

British Geological Survey
Engineering Geology and Geophysics Group

Technical Report WN/95/37

**Methods for the recognition of geological
weakness zones and other surface
discontinuities caused by underground
mining in Carboniferous terrain**

Final Report. Part 2: Figures

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P I Meldrum, R J Peart, M G Raines and C Williams

The **Final Report** comprises the volumes - **Part 1: Text**
Part 2: Figures

Bibliographic Reference :

Beamish, D, Flint R C, Greenwood, P G, Jackson, P D
Meldrum, P I, Peart, R J, Raines, M G, Williams, C
Methods for the recognition of geological weakness
zones and other surface discontinuities caused by
underground mining in Carboniferous terrain.
British geological Survey,
Technical Report, WN/95/37

Research funded in part by the
Commission of the European
Communities European Coal and
Steel Community.
EC Contract No. 7220/AF/136

British Geological Survey, Keyworth, Nottingham, NG12 5GG

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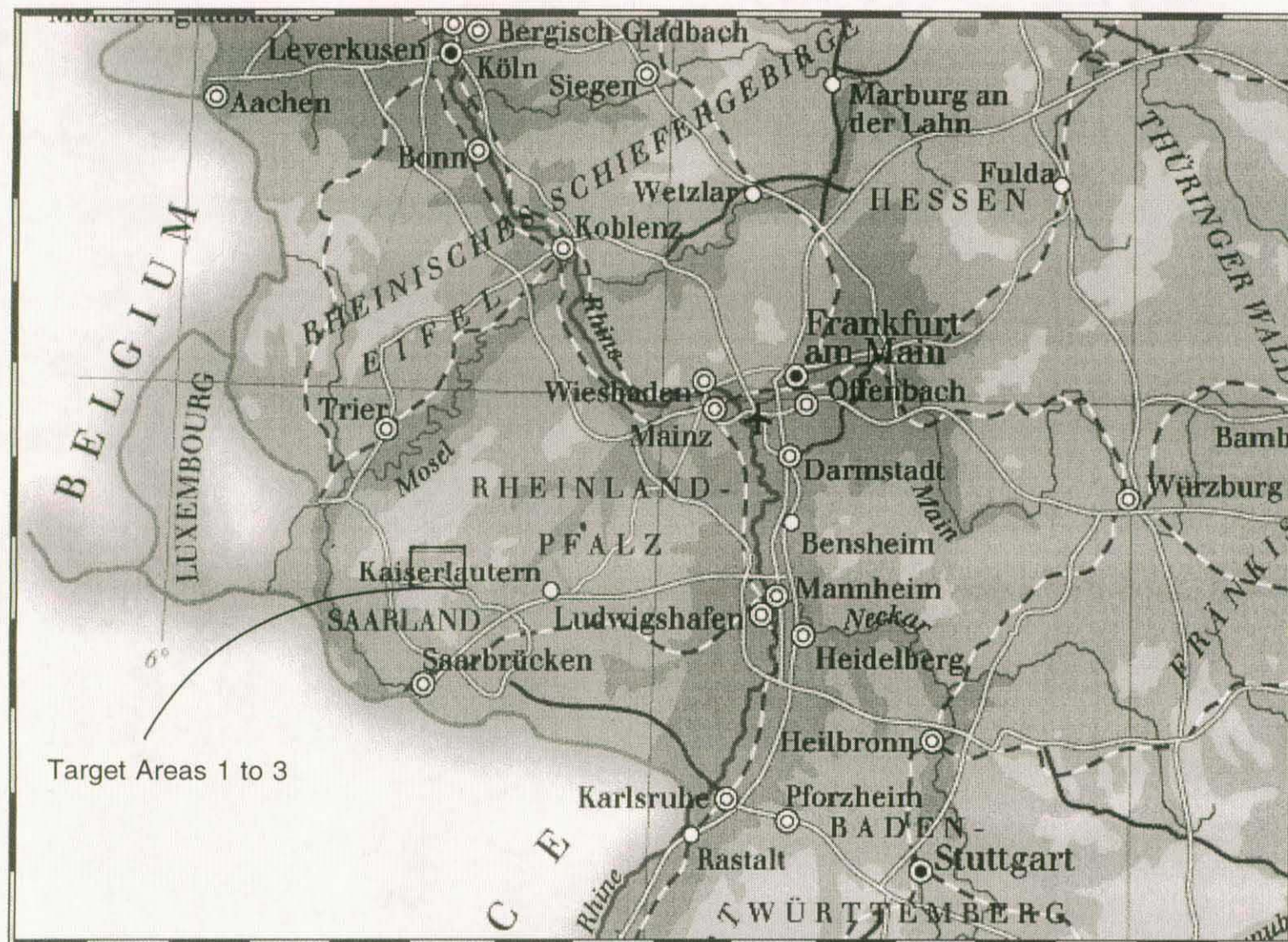
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After Dorling Kindersley Multimedia (1995)

Figure 1a. Location map for Saarland.

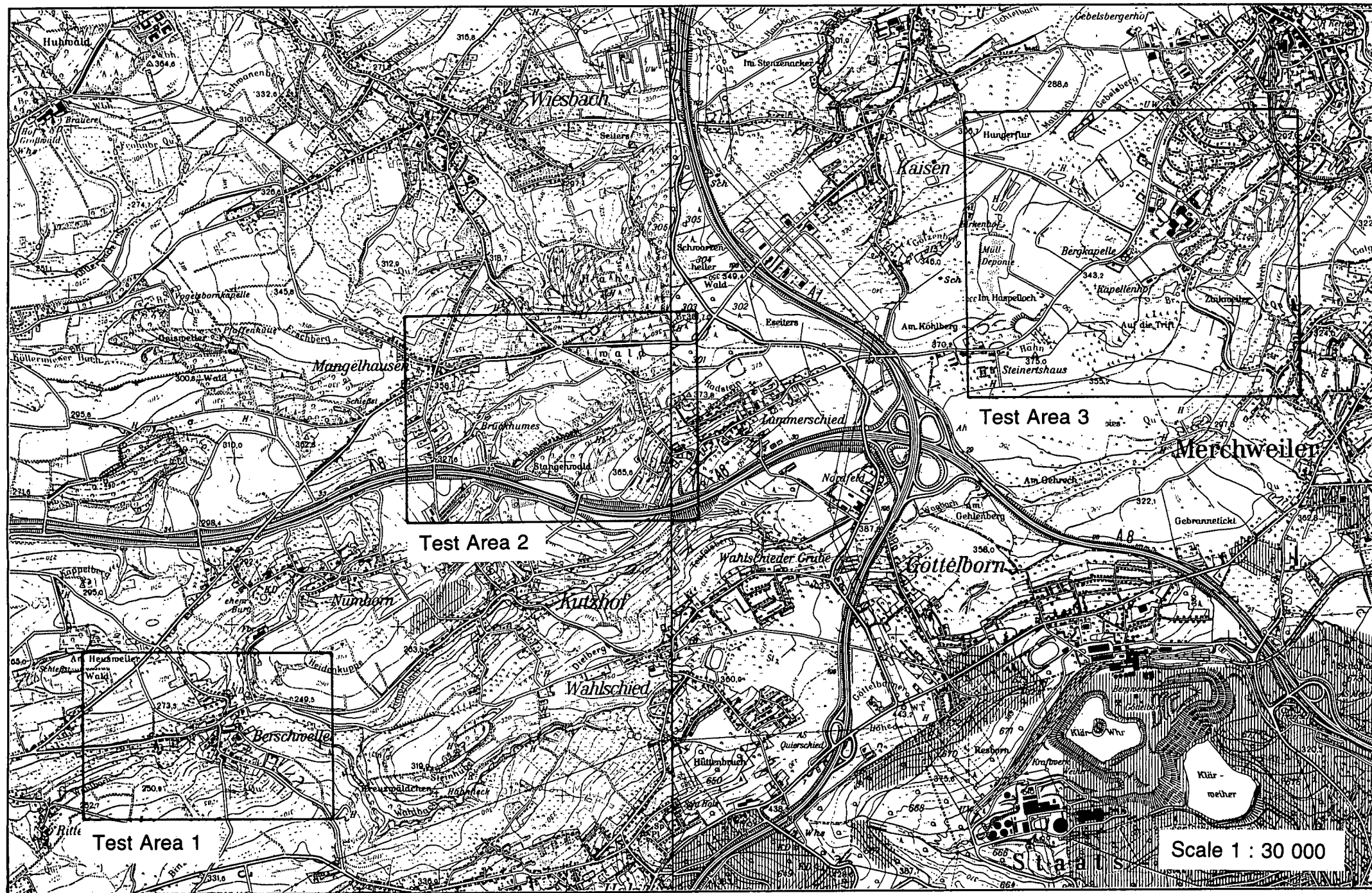


Figure 1b. Location map for Target Areas 1 to 3.

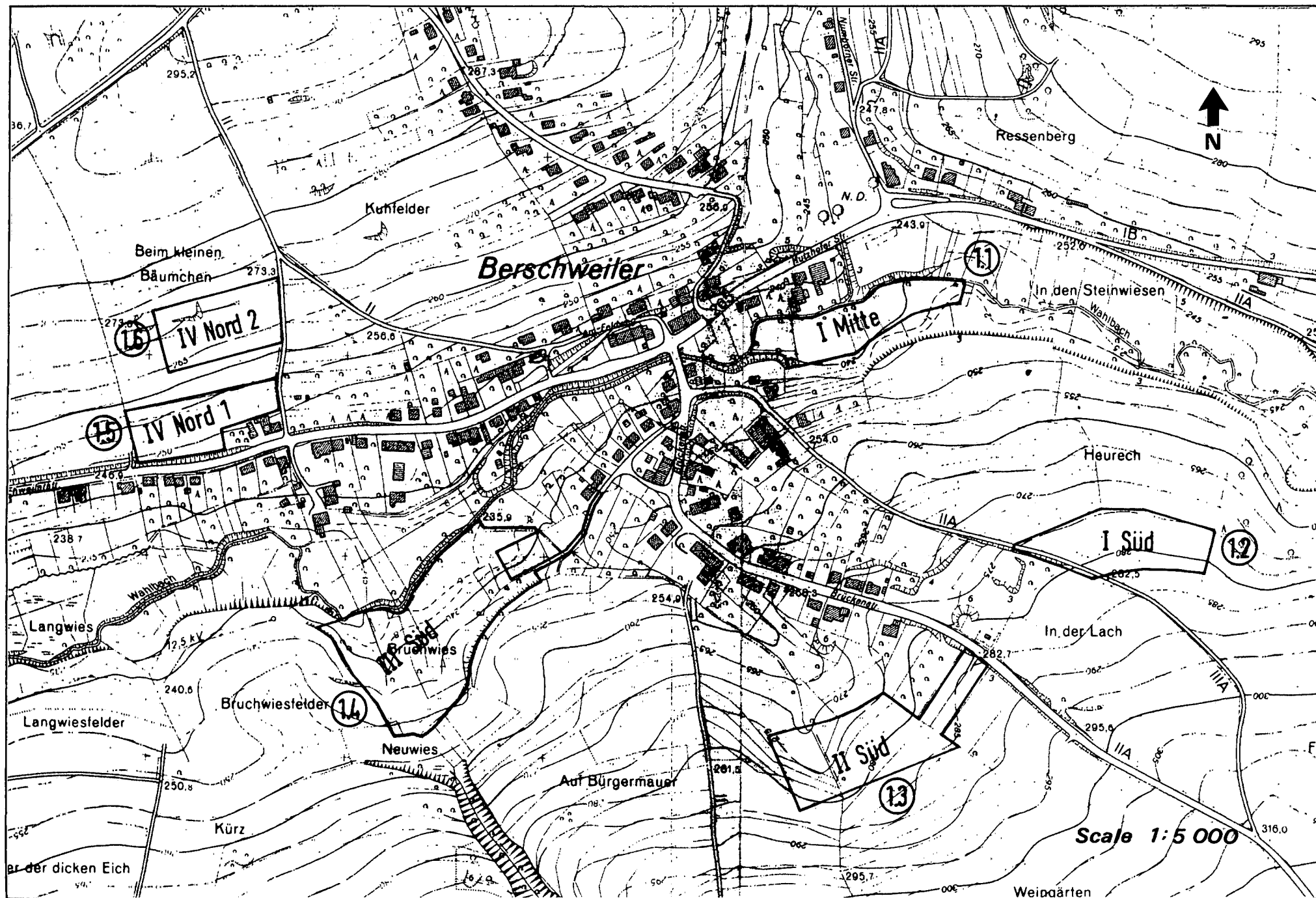


Figure 2. Location map for Test Sites 1.1 to 1.6.

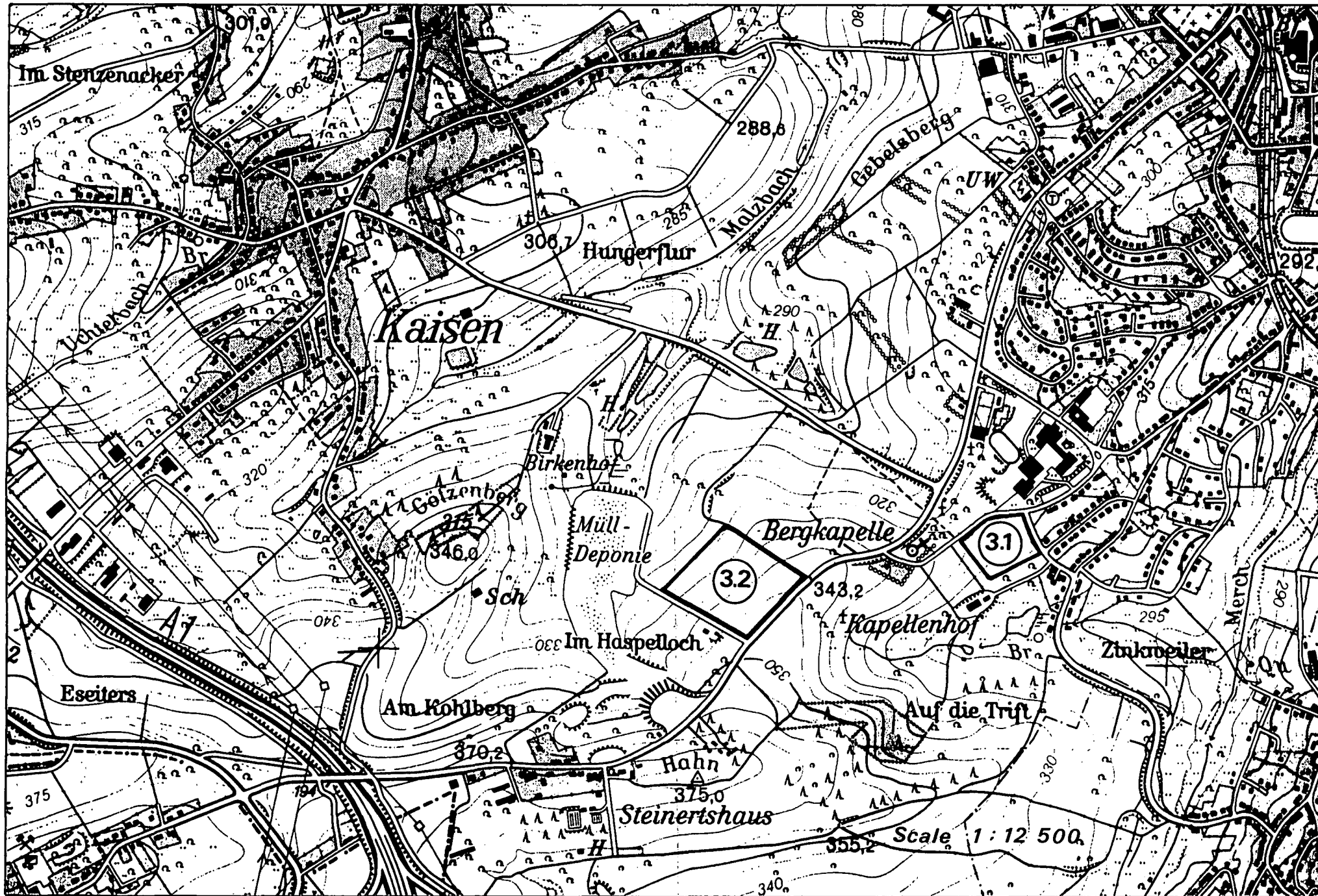
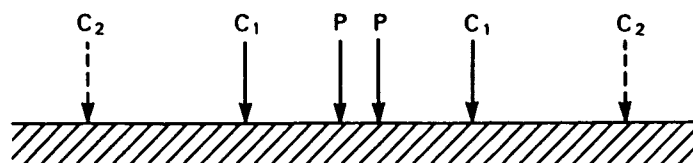
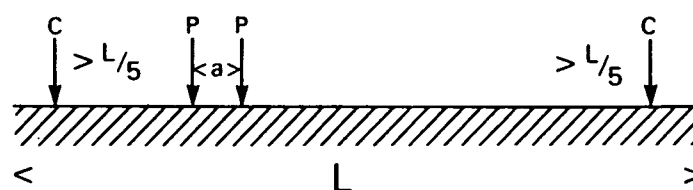


Figure 4. Location map for Test Sites 3.1 to 3.2 and 3.2 (Ext).

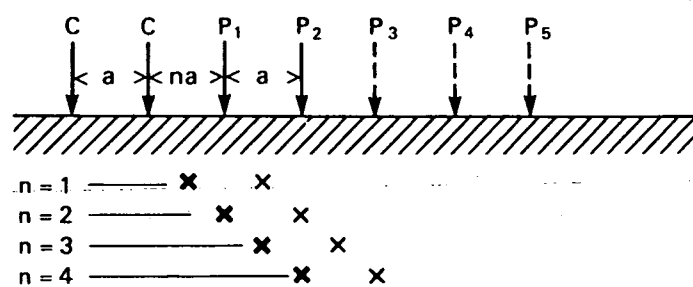
SCHLUMBERGER



GRADIENT



DIPOLE-DIPOLE



POLE - POLE

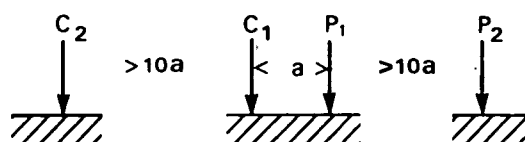
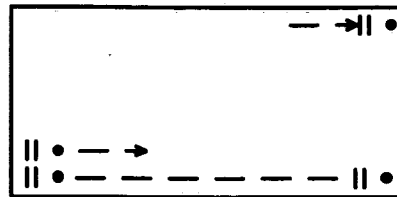


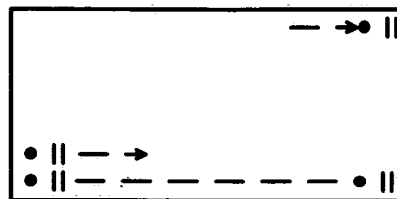
Figure 1 res.

Electrode arrays used for the resistivity surveys.

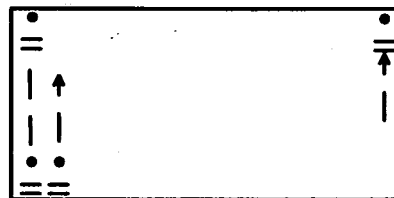
Half Schlumberger is split into four measurement styles
A,B and C,D.



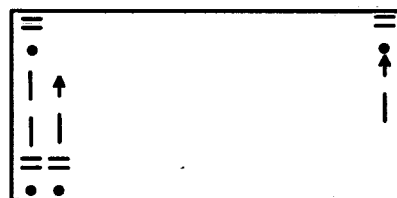
Style A



Style B



Style C



Style D

= Potential Electrodes
• Current Electrode

Figure 2 *resc.* The 2D electrode grid used for RESCAN surveys, and the definition of the 'half Schlumberger' mapping technique.

Decay of E-field amplitude in homogenous materials

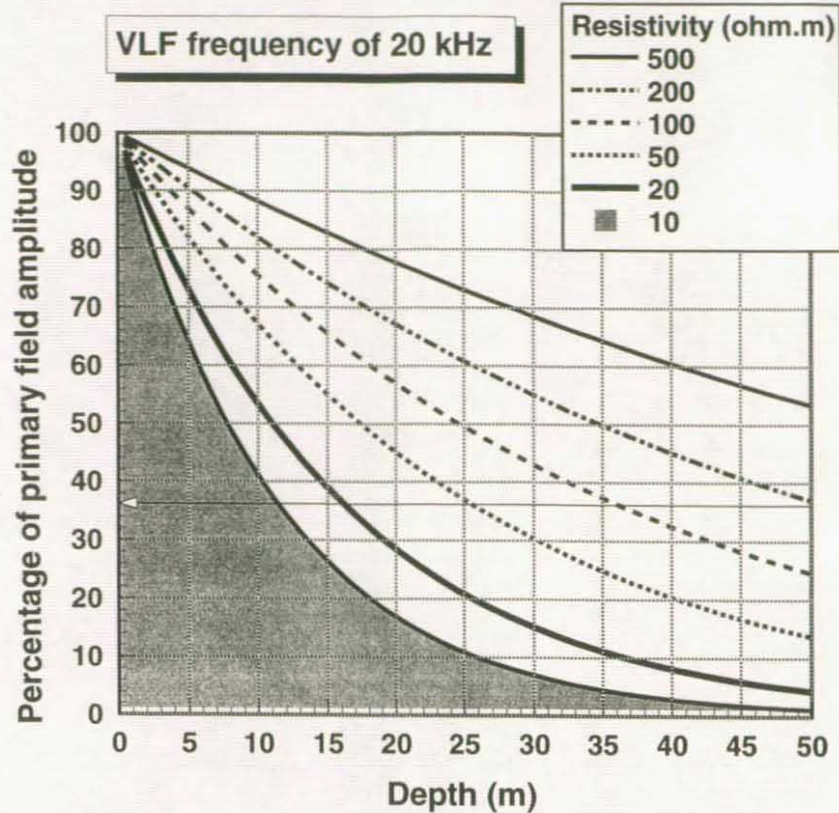


Figure 1 vlf. Depth of investigation of VLF EM fields.

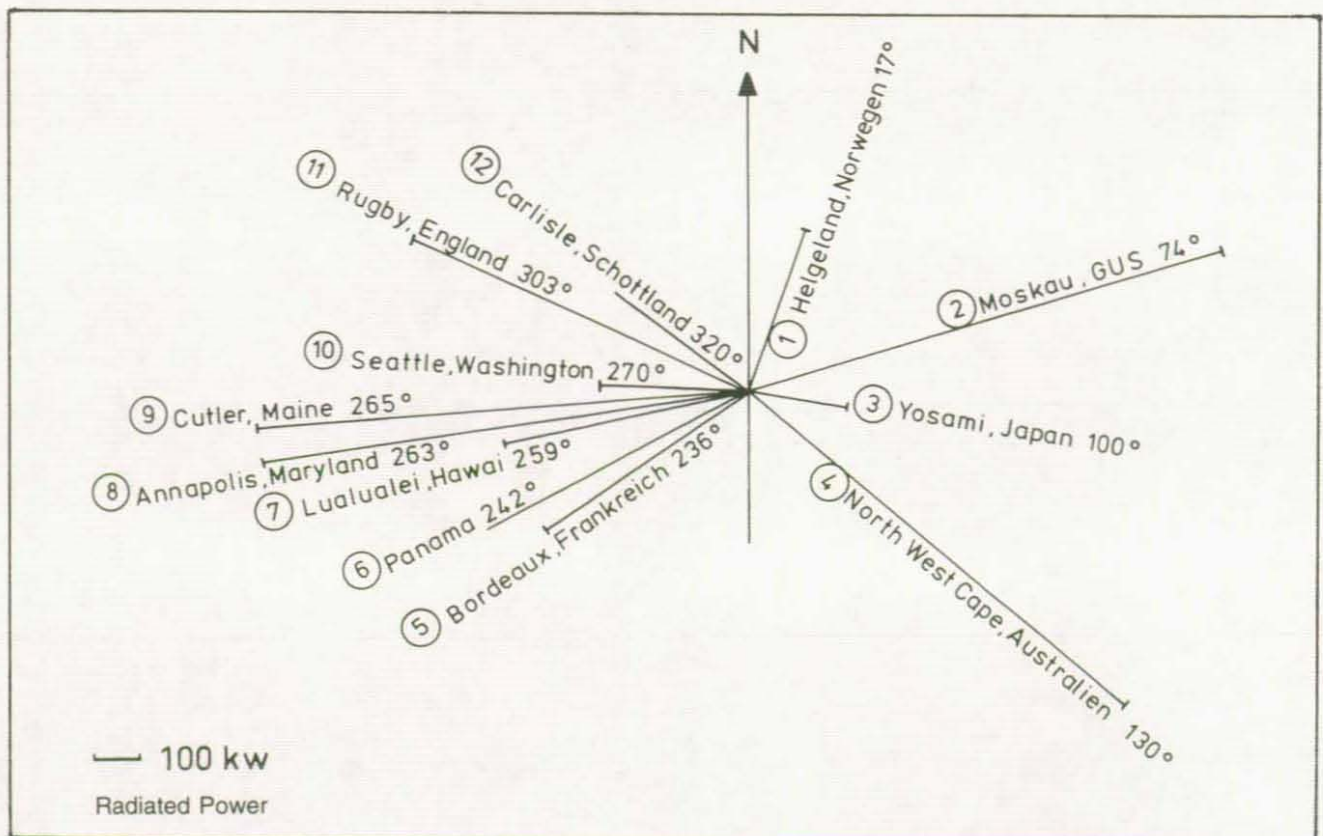
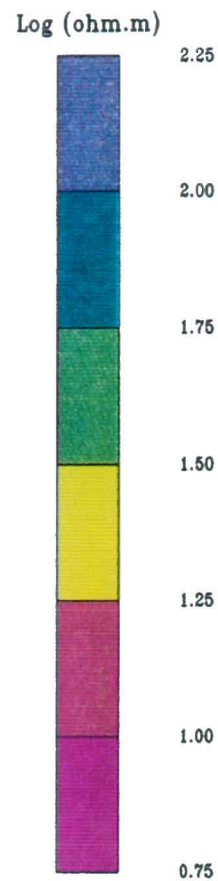
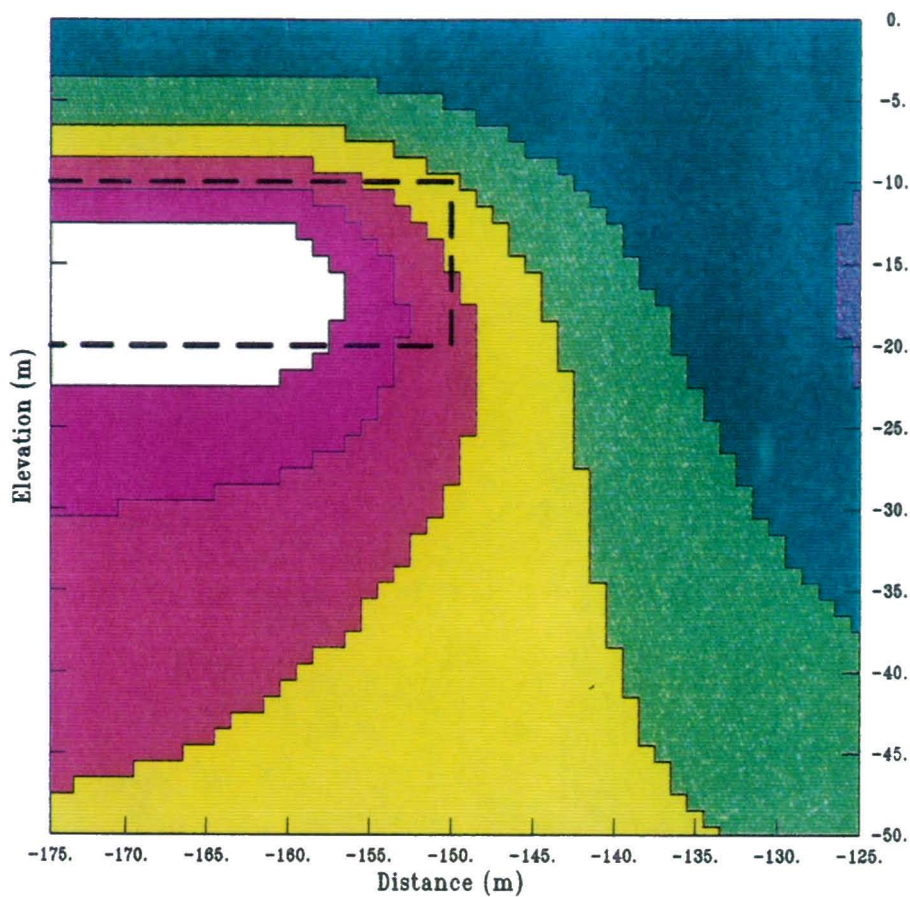


Figure 2 vlf. Azimuths of VLF transmitters relative to Test Areas 1, 2, and 3.

VLF SYNTHETIC, 2d OCCAM INVERSION (TE,1f)



VLF SYNTHETIC, 2d OCCAM INVERSION (TE,2f)

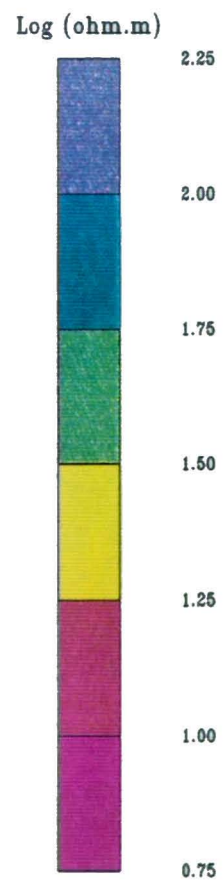
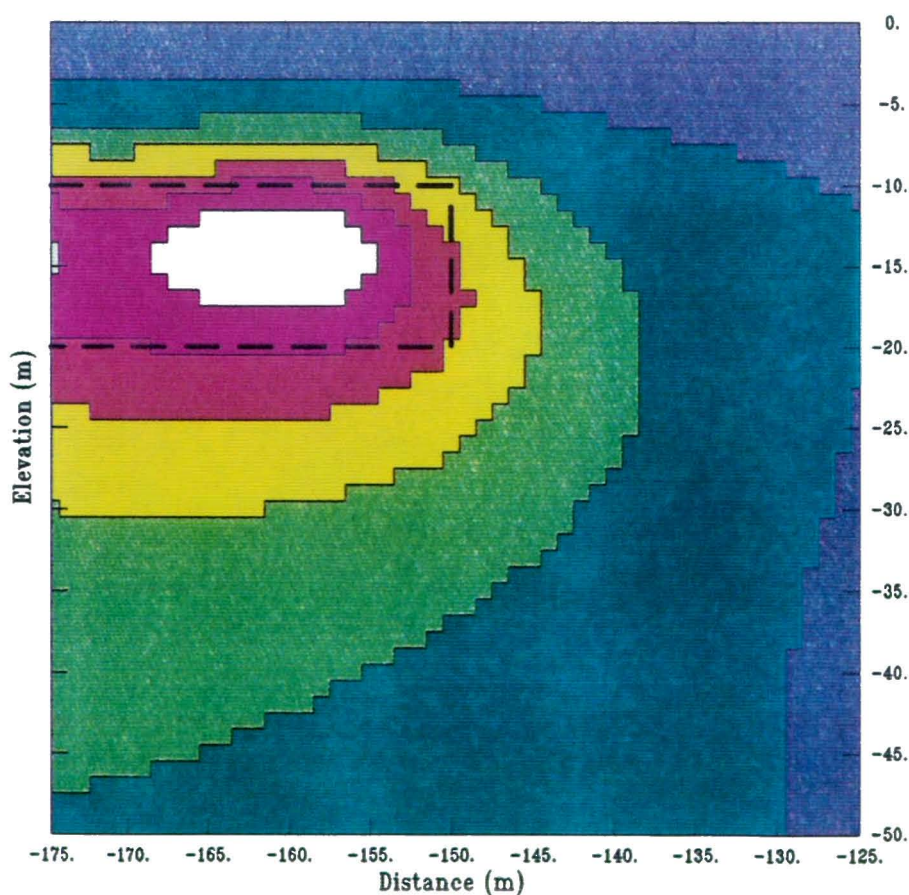
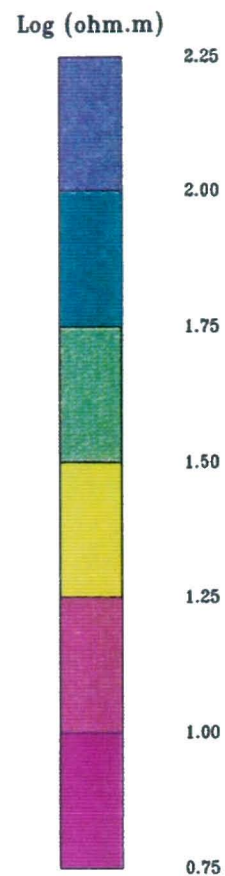
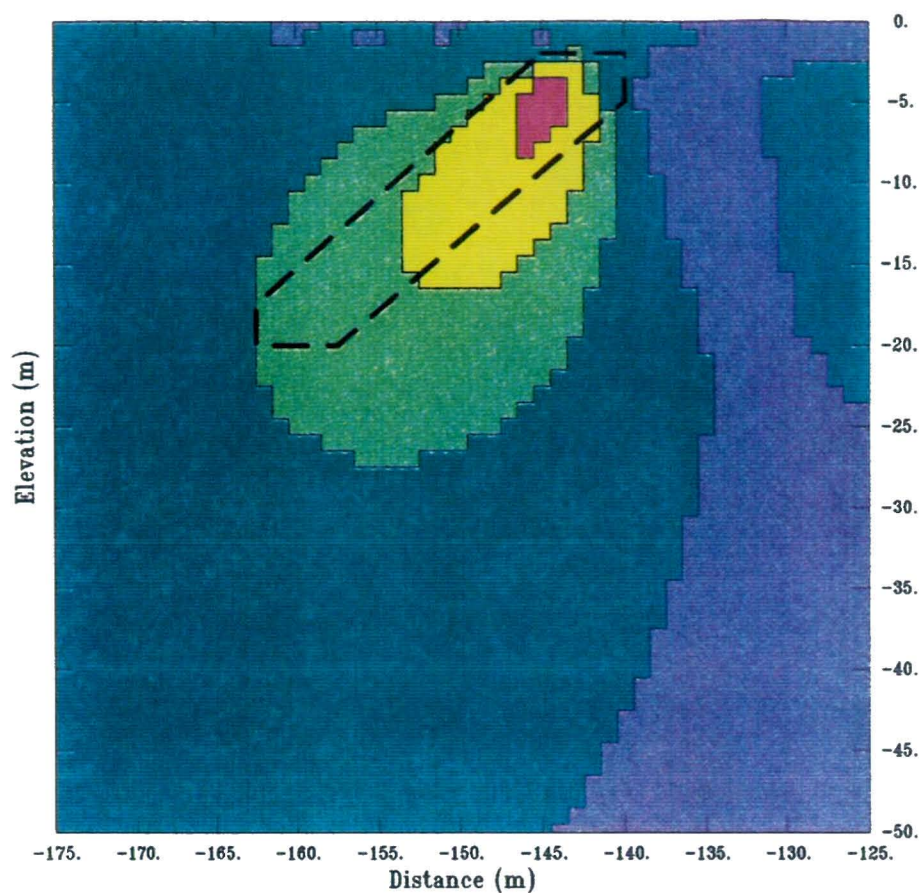


Figure 3 *vlf*. Synthetic VLF model for non-dipping target.

VLF SYNTHETIC, 2d OCCAM INVERSION (TM,1f)



VLF SYNTHETIC, 2d OCCAM INVERSION (TM,2f)

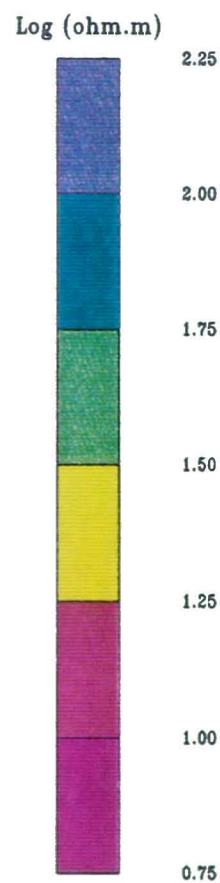
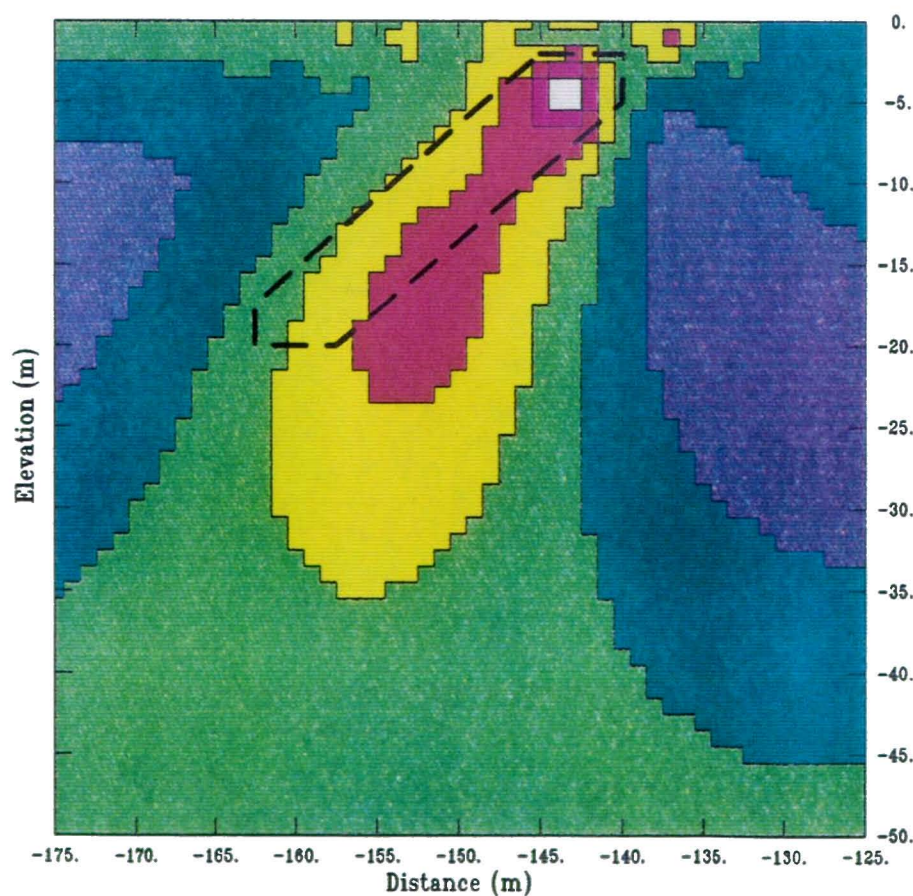
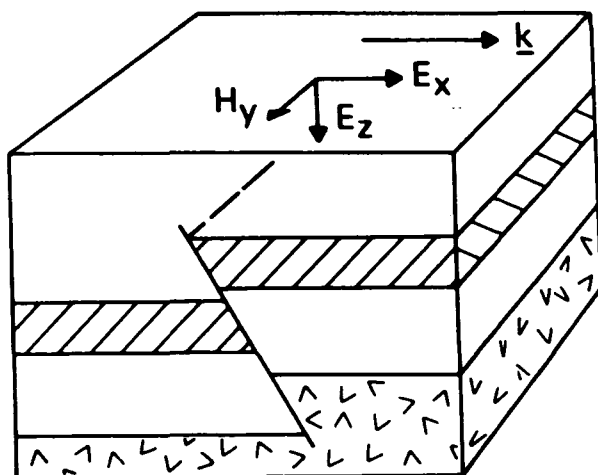


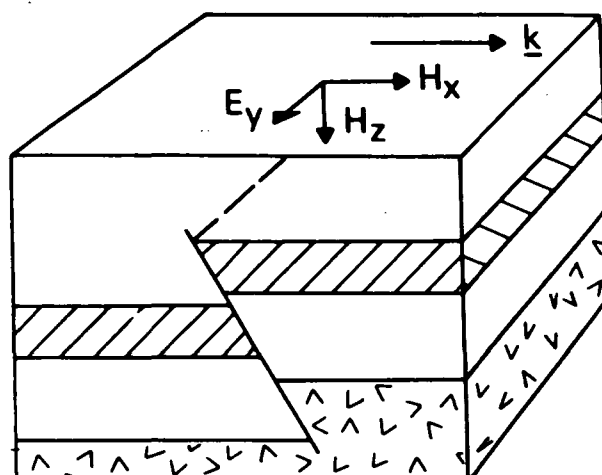
Figure 4 *vlf*. Synthetic VLF model for dipping target.

\underline{k} is the direction of propagation of the VLF E field



H polarisation

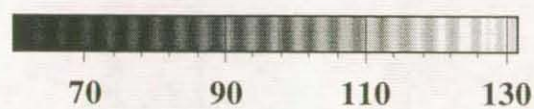
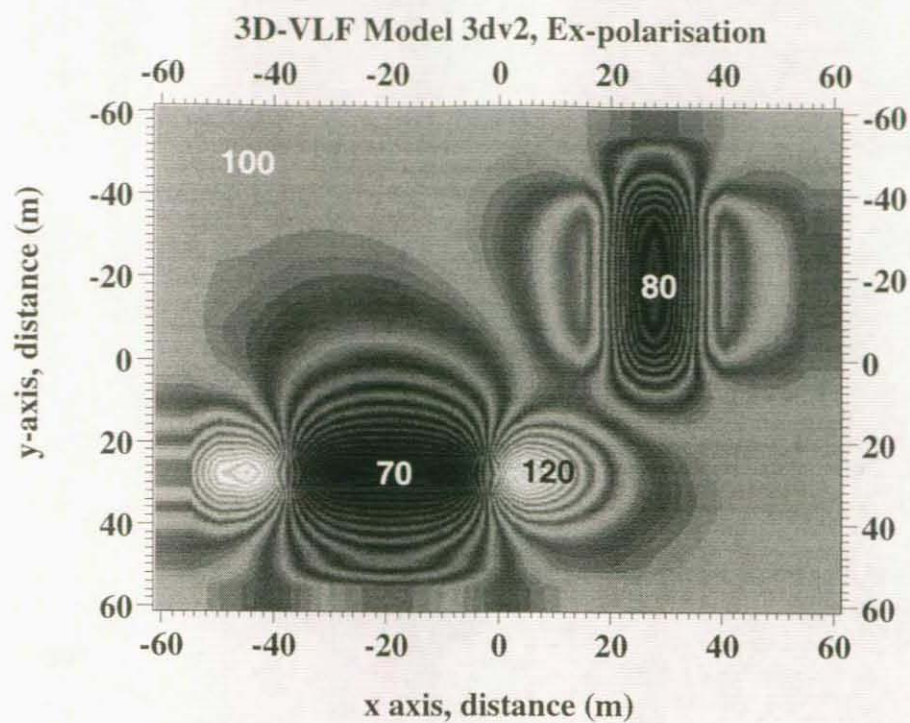
TM mode. Magnetic field parallel to strike



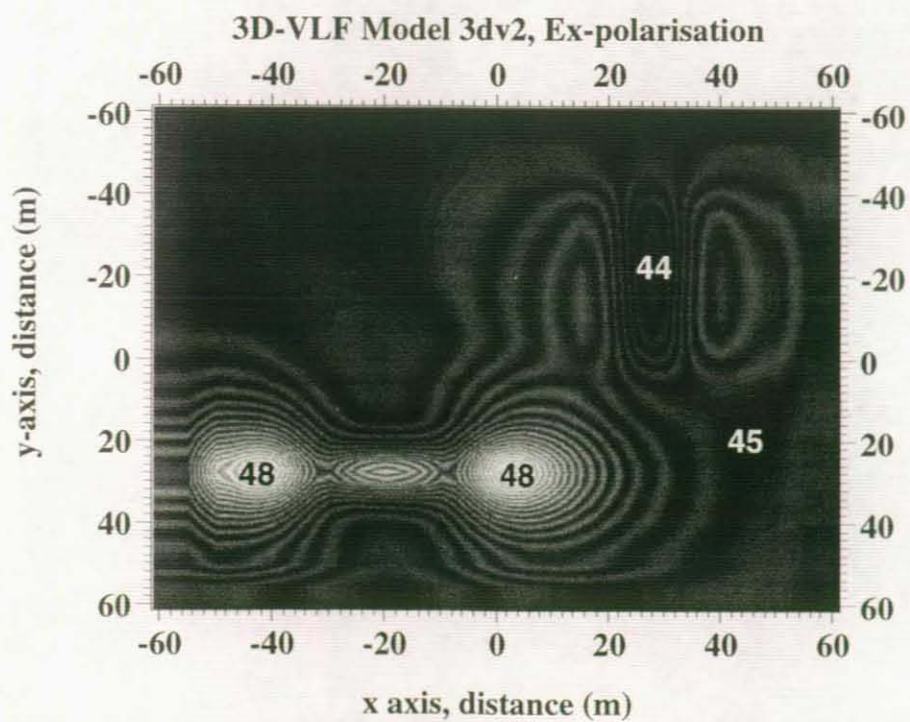
E polarisation

TE mode. Electric field parallel to strike

Figure 5 *vlf*. Principal components of the VLF field.



Apparent resistivity (ohm.m)



Phase (degrees)

Figure 6 vlf. VLF modelling. Model 1: apparent resistivity and phase.

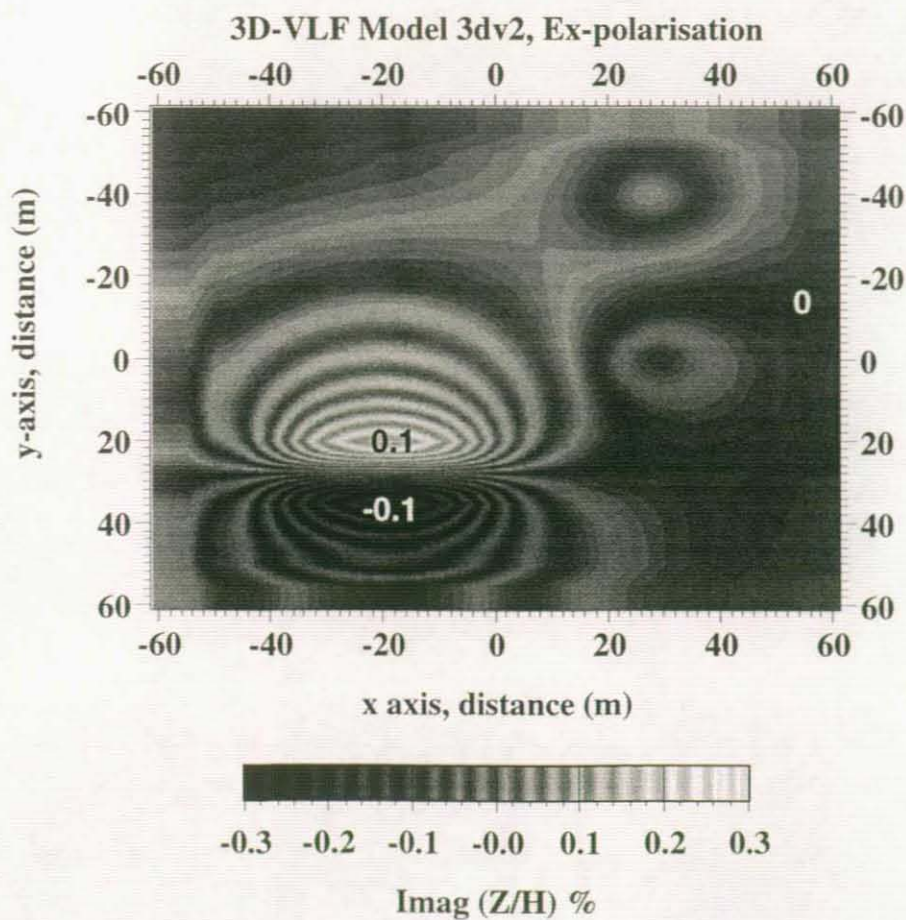
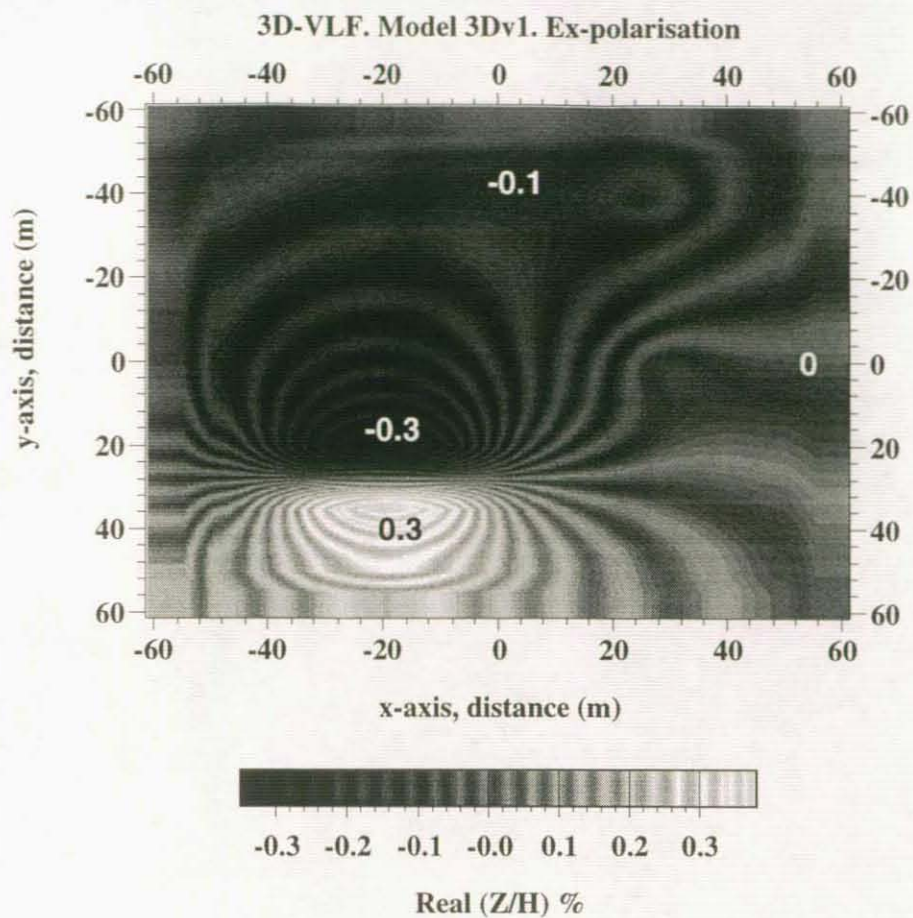


Figure 7 *vlf*. VLF modelling. Model 1: Z field ratios.

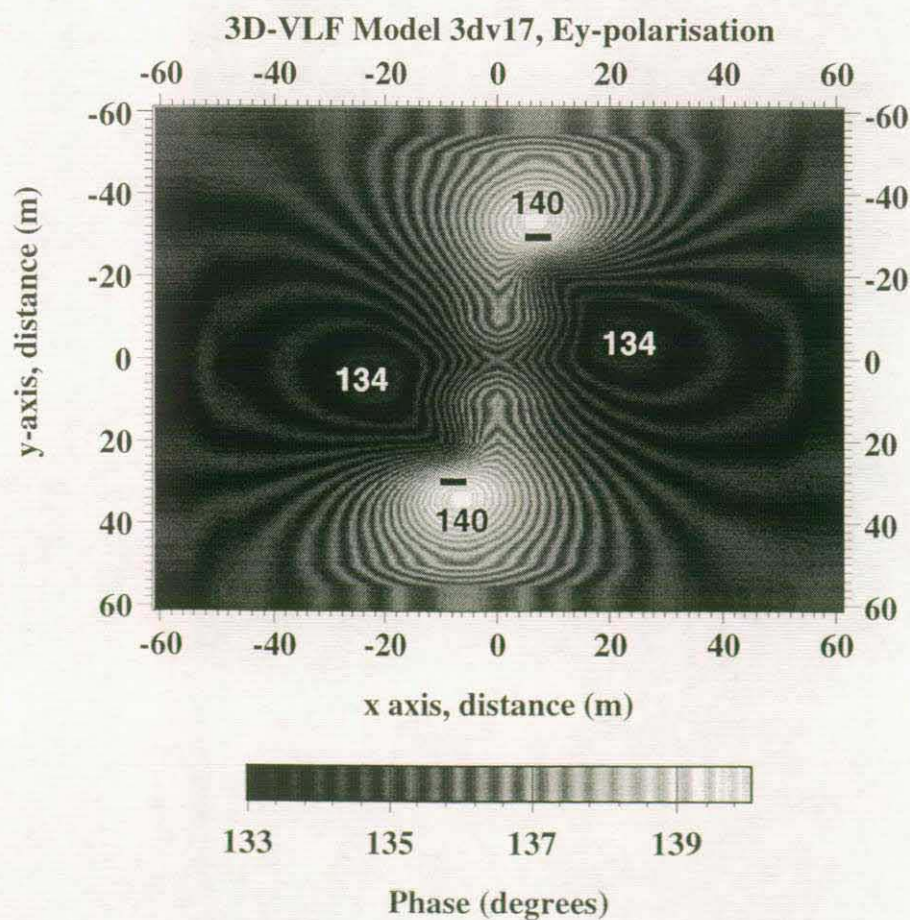
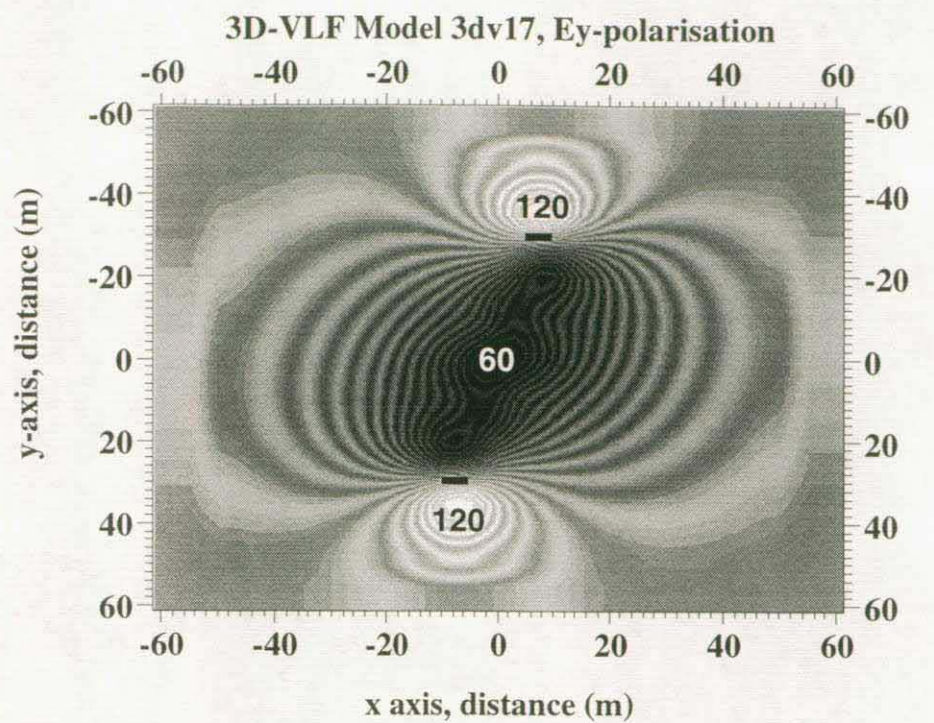


Figure 8 *vlf*. VLF modelling. Model 2: apparent resistivity and phase, E_y polarisation.

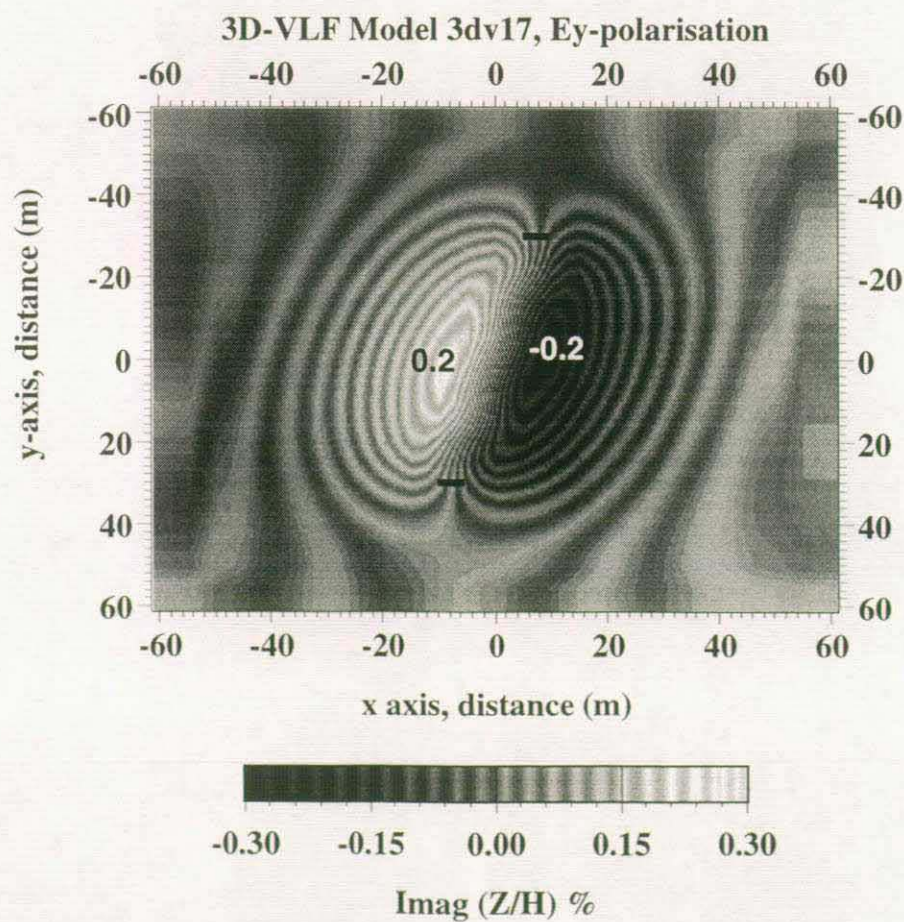
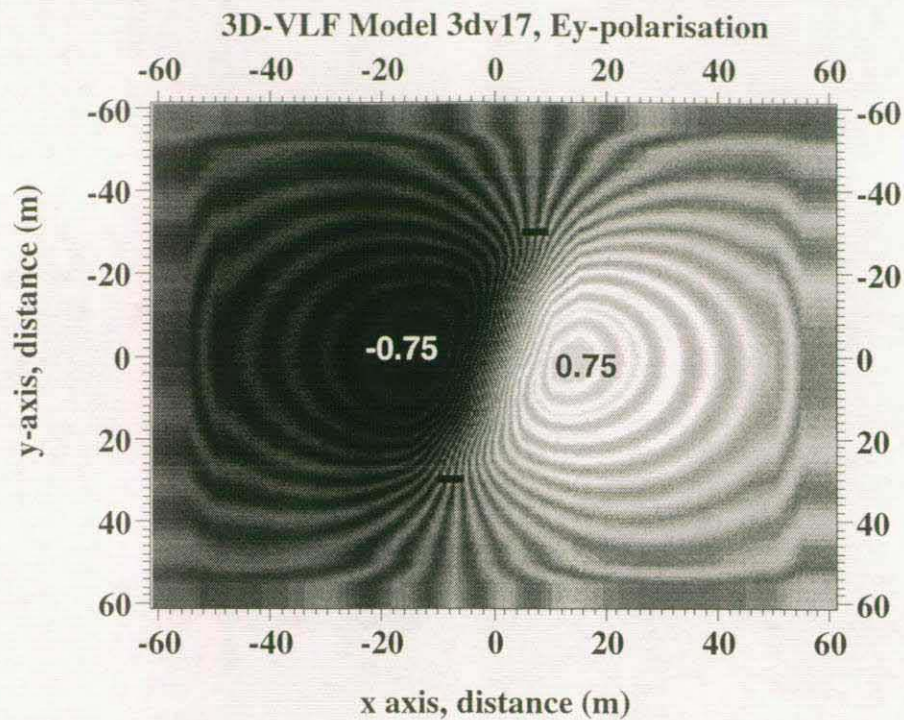


Figure 9 *vlf*. VLF modelling. Model 2: Z field ratios, E_y polarisation.

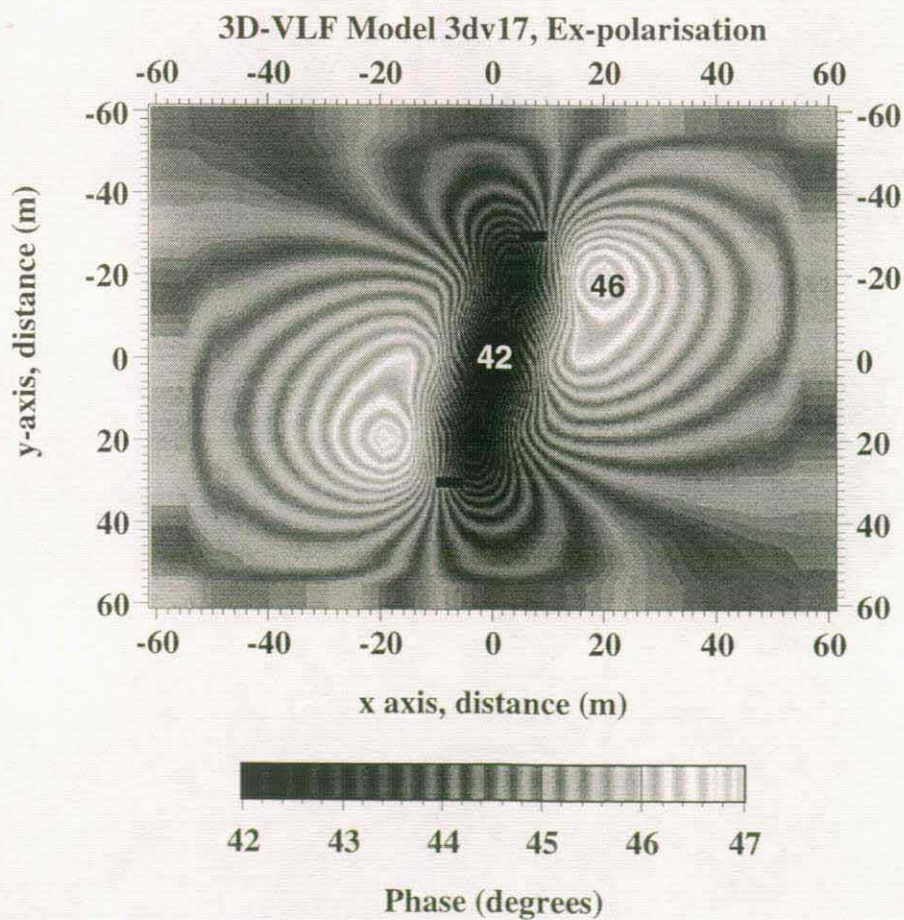
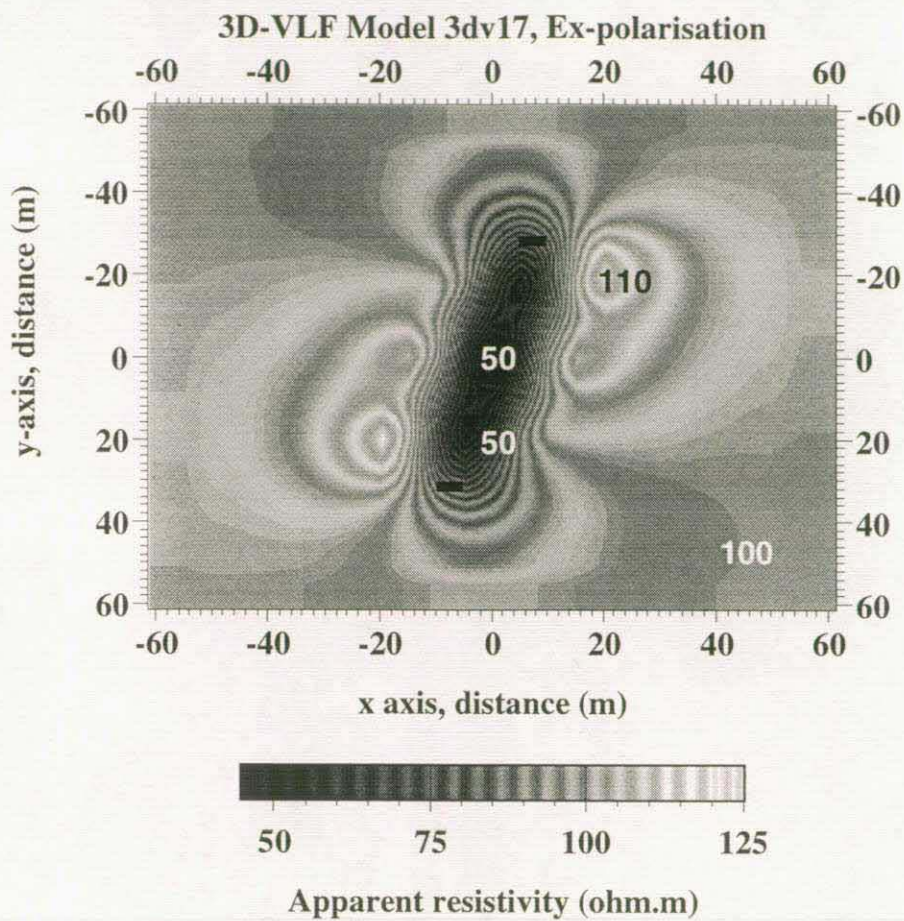


Figure 10 vlf. VLF modelling. Model 2: apparent resistivity and phase, E_x polarisation.

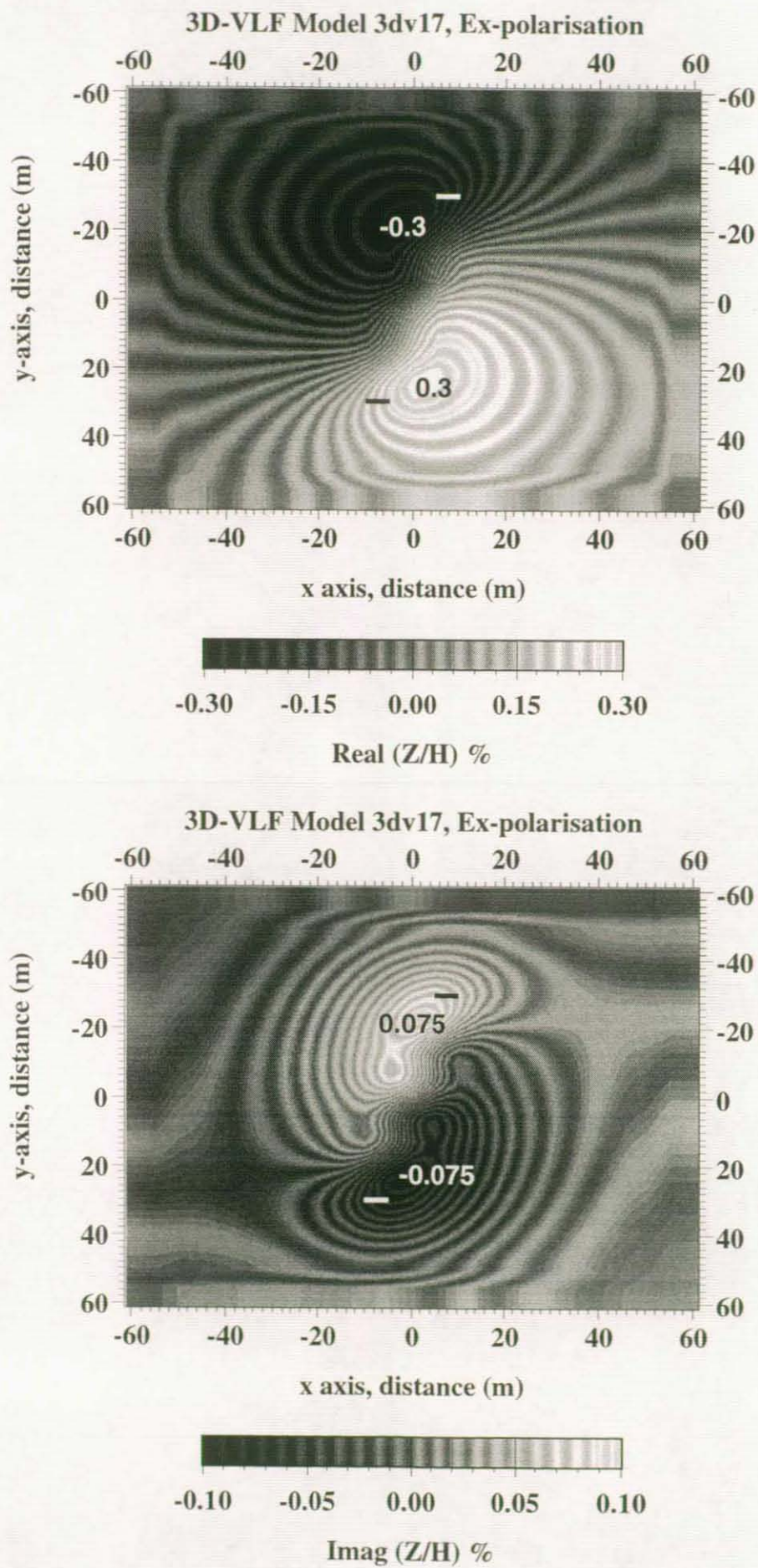


Figure 11 *vlf*. VLF modelling. Model 3: Z field ratios, E_x polarisation.

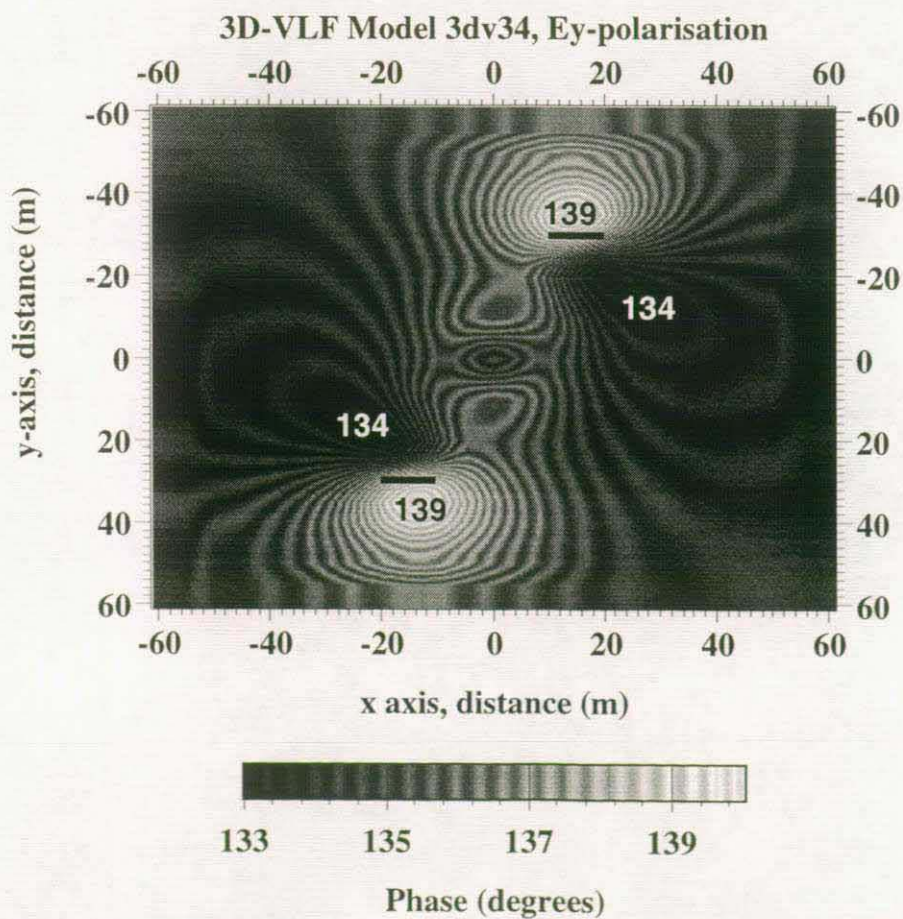
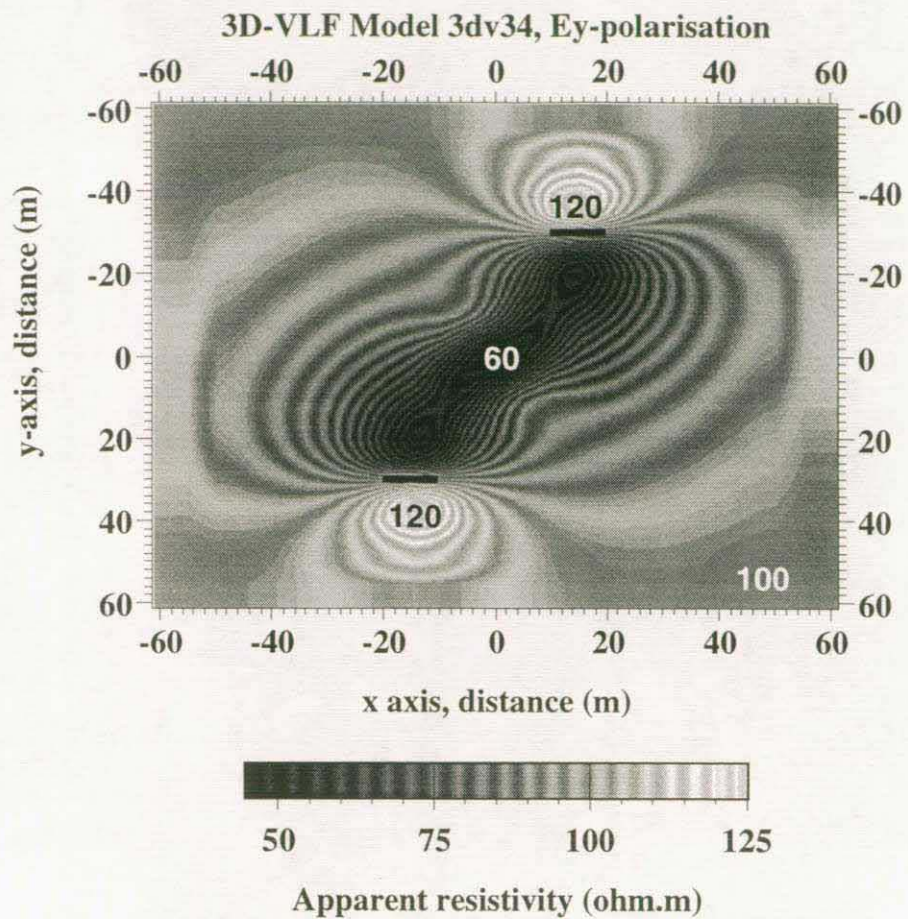


Figure 12 *vlf*. VLF modelling. Model 3: apparent resistivity and phase, E_y polarisation.

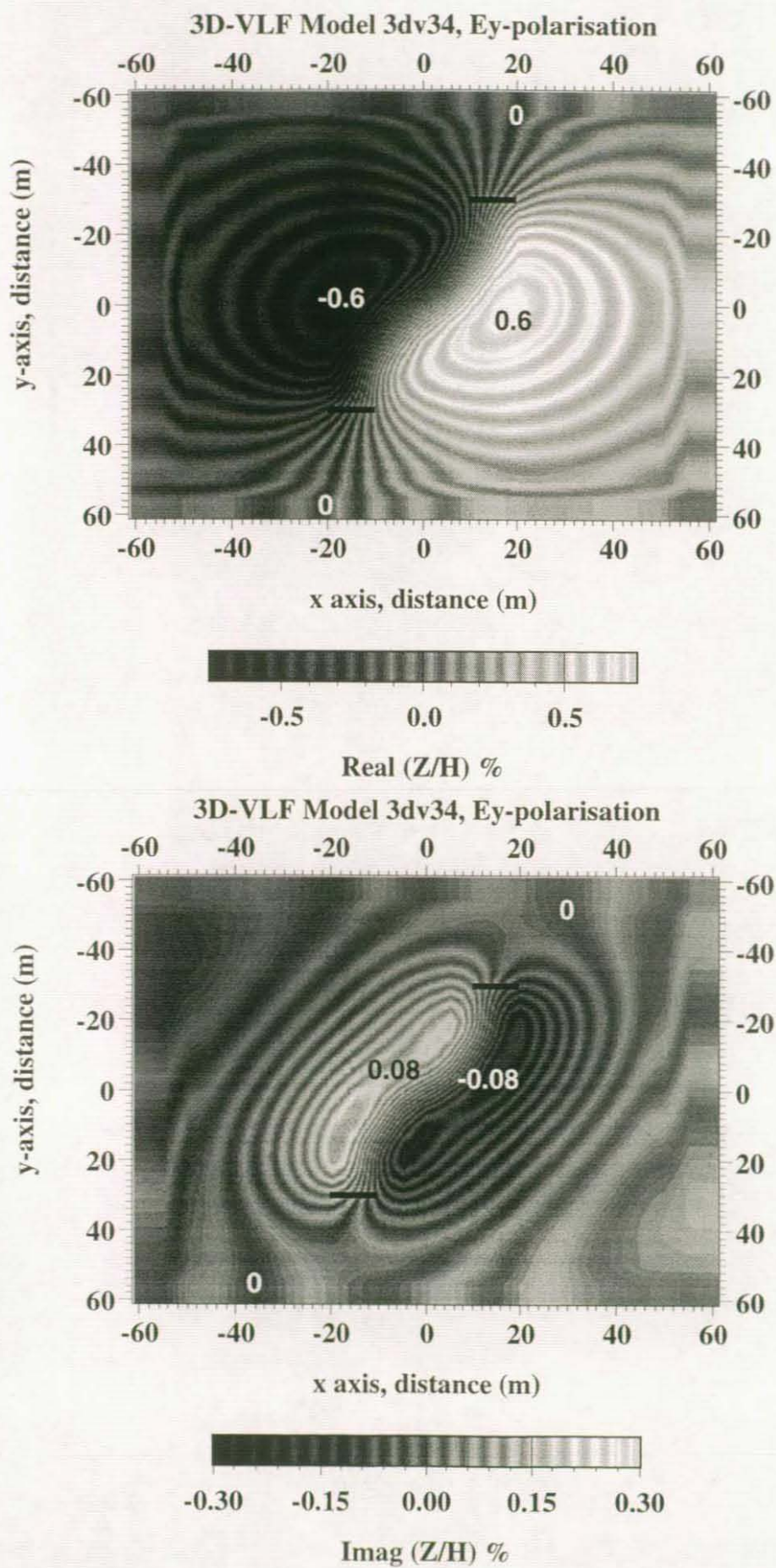


Figure 13 vlf. VLF modelling. Model 3: Z field ratios, E_y polarisation.

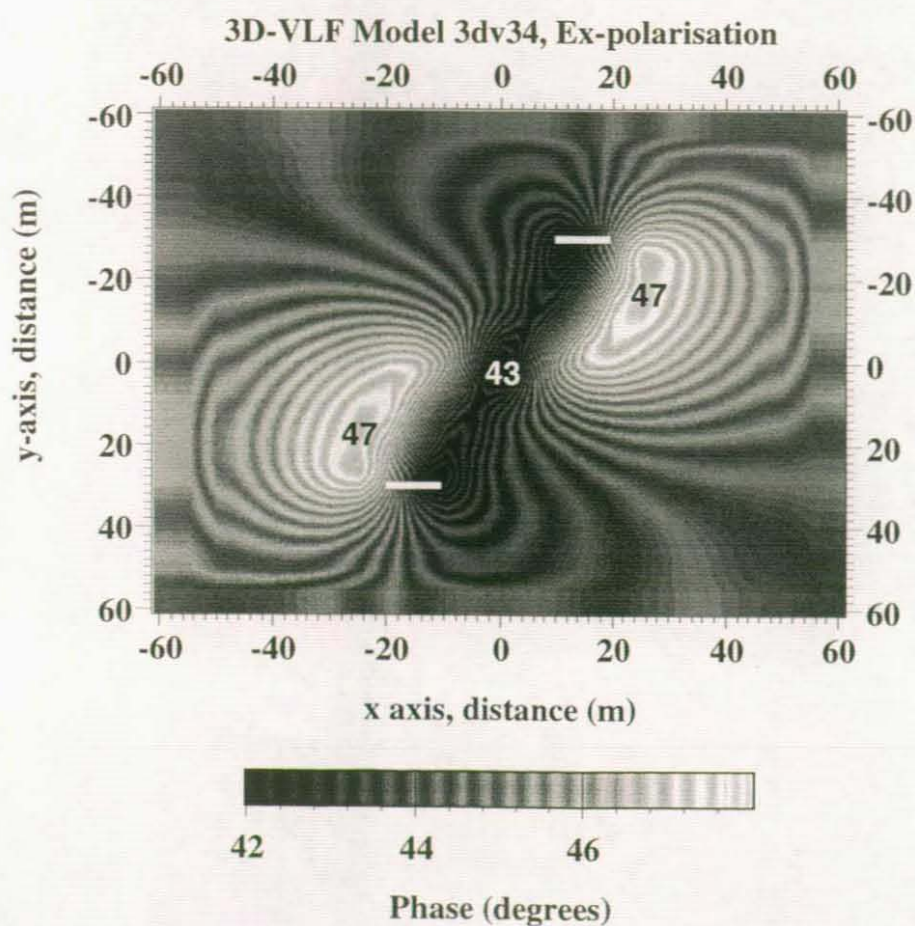
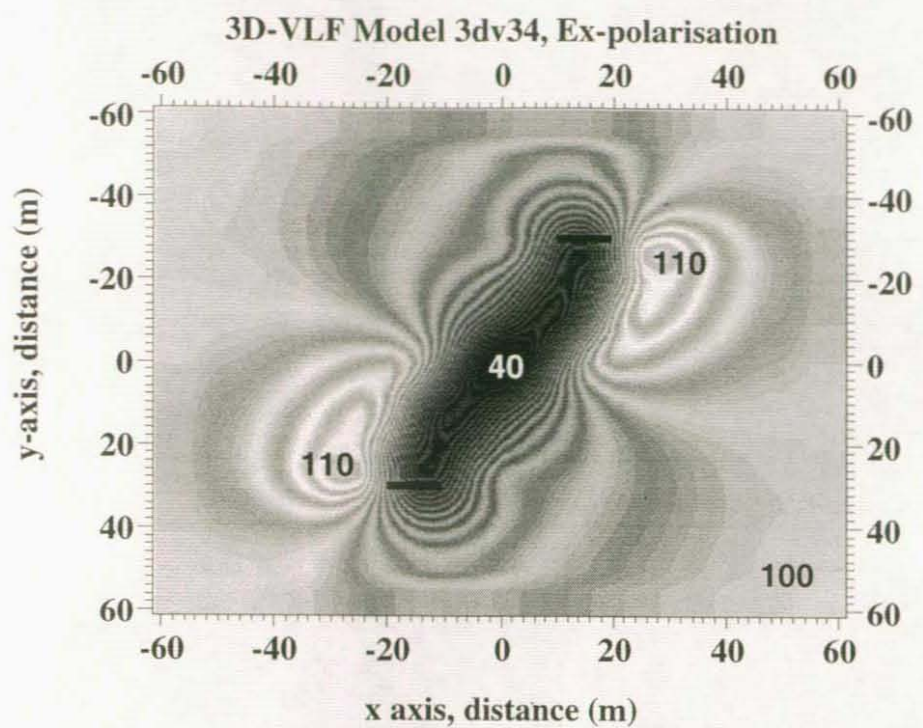


Figure 14 *vlf*. VLF modelling. Model 3: apparent resistivity and phase, E_x polarisation.

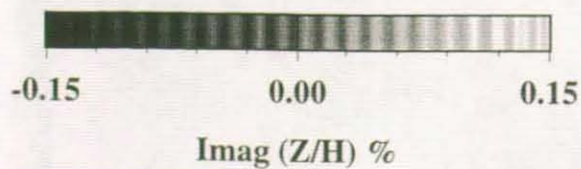
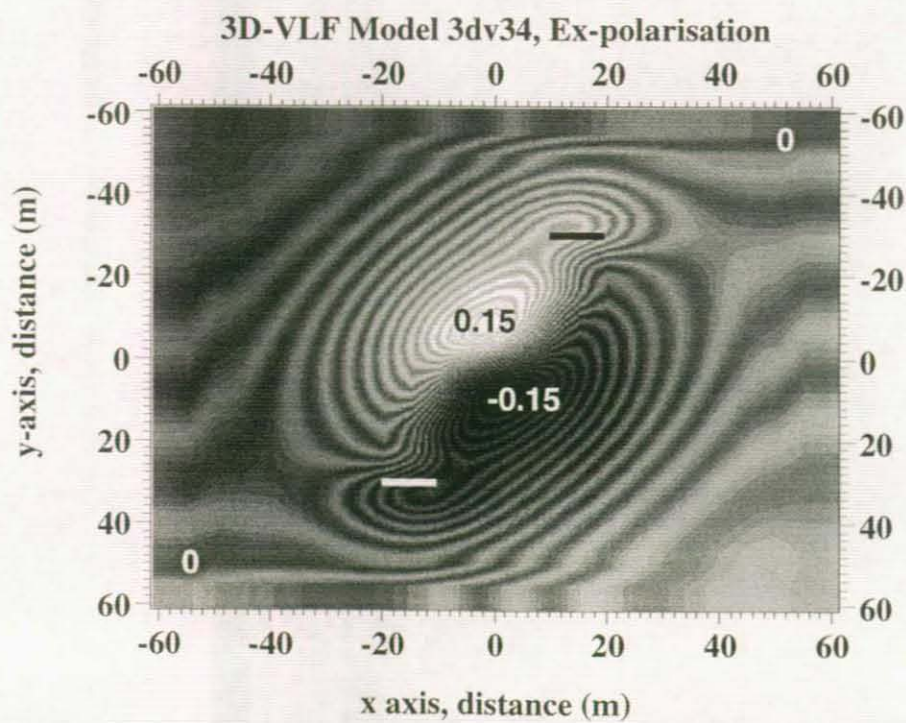
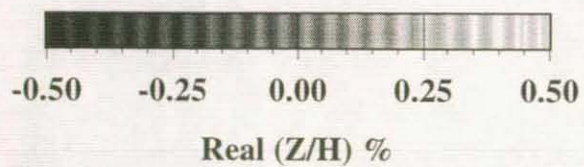
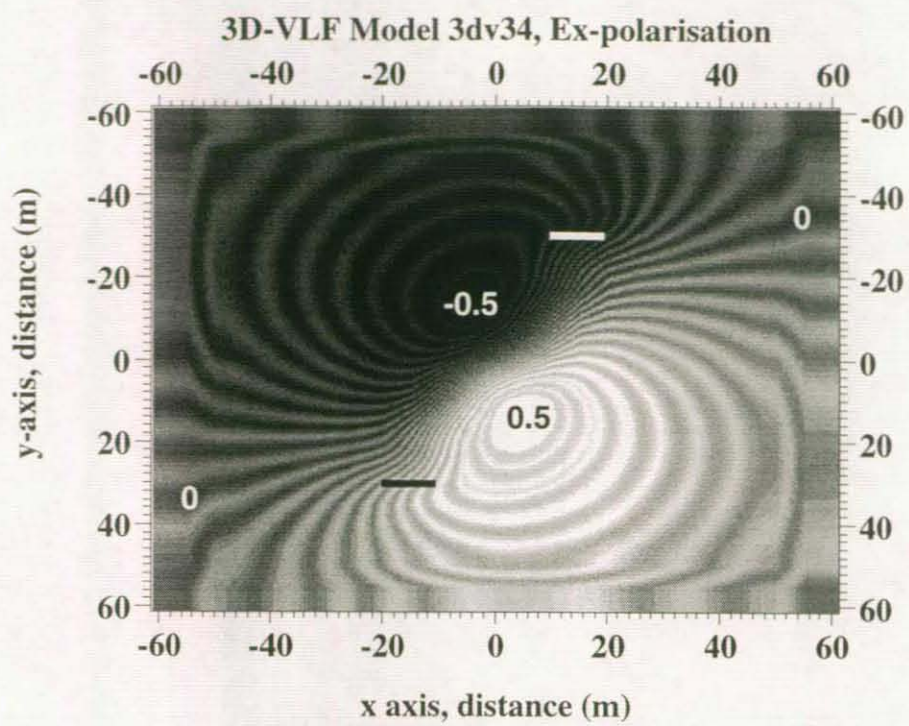


Figure 15 *vlf*. VLF modelling. Model 3: Z field ratios, E_x polarisation.

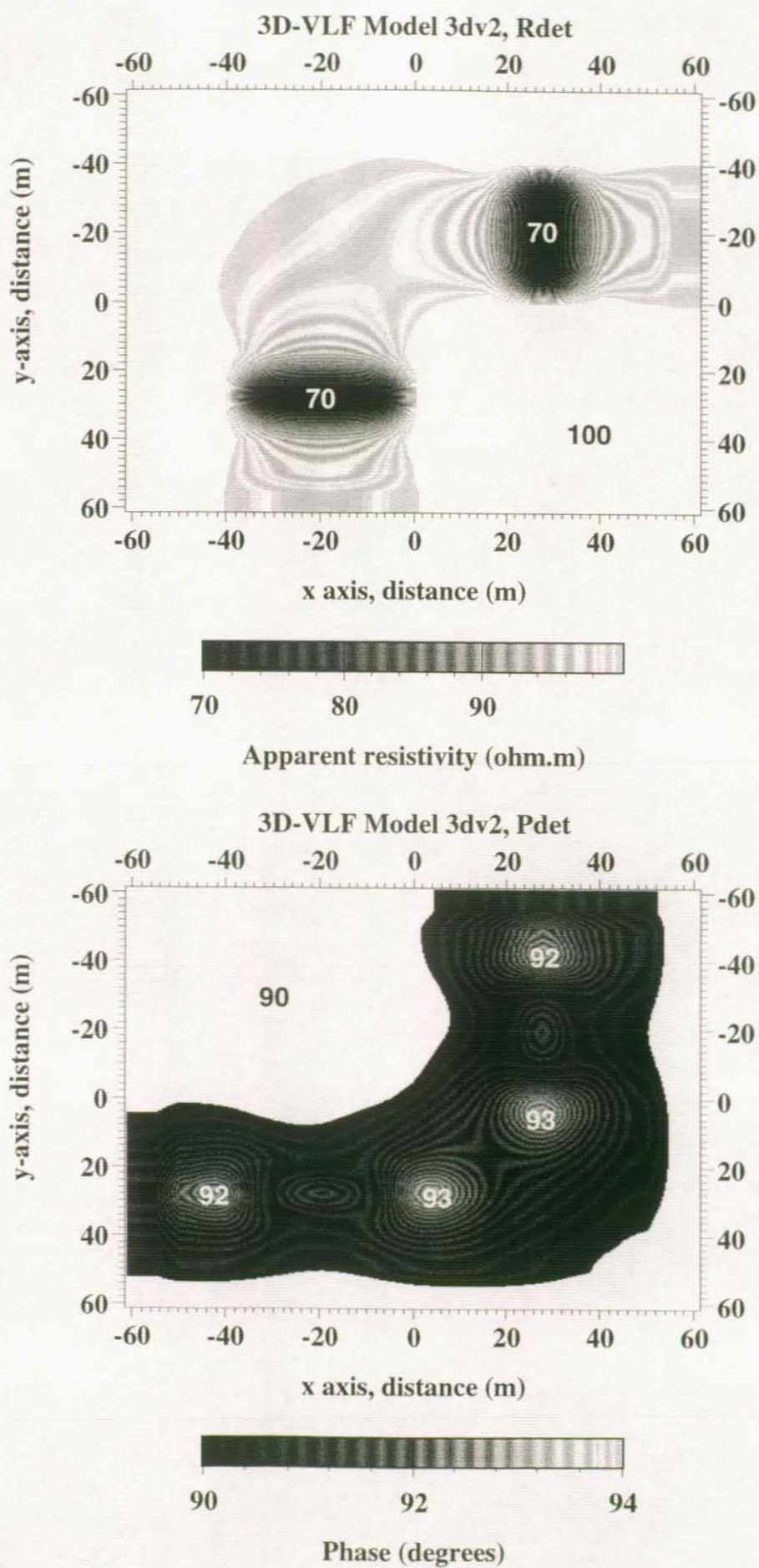


Figure 16 *vlf*. VLF modelling. Model 1: use of rotational invariants.

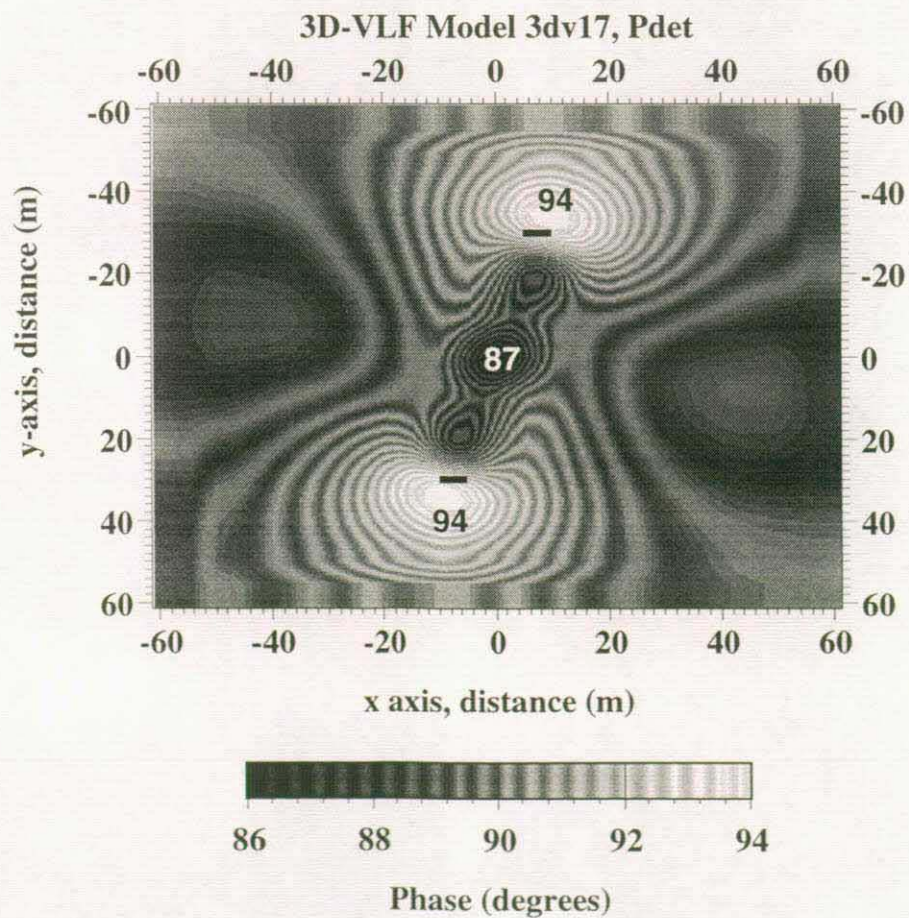
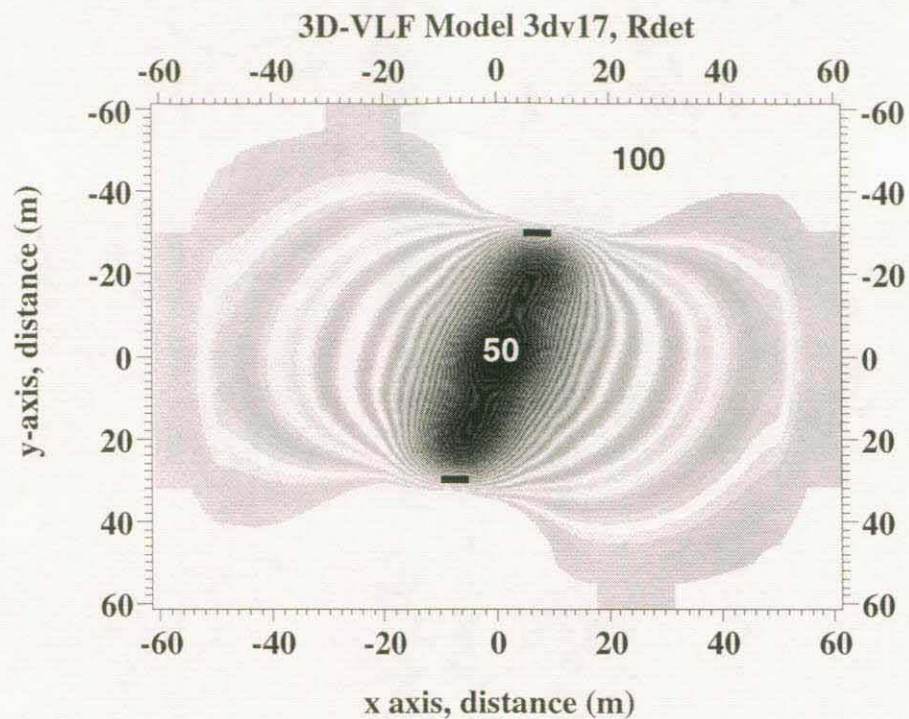


Figure 17 *vlf*. VLF modelling. Model 2: use of rotational invariants.

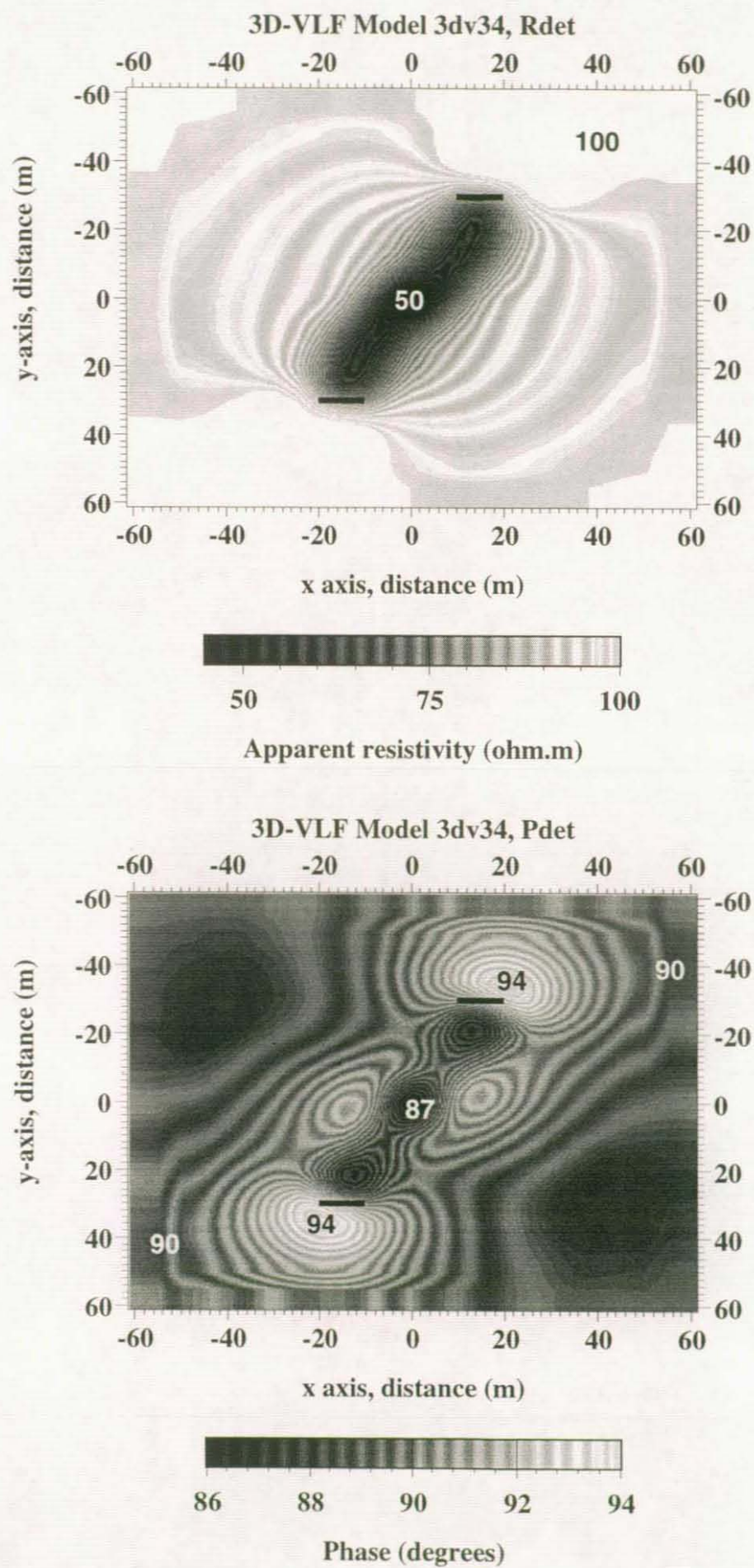
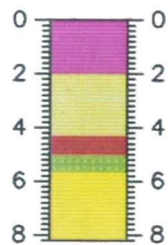
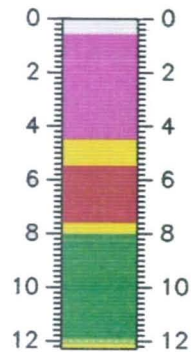


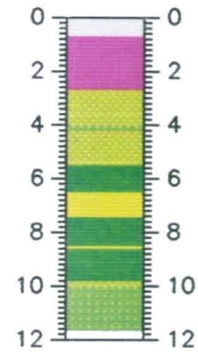
Figure 18 *vlf*. VLF modelling. Model 3: use of rotational invariants.



BK 1.12

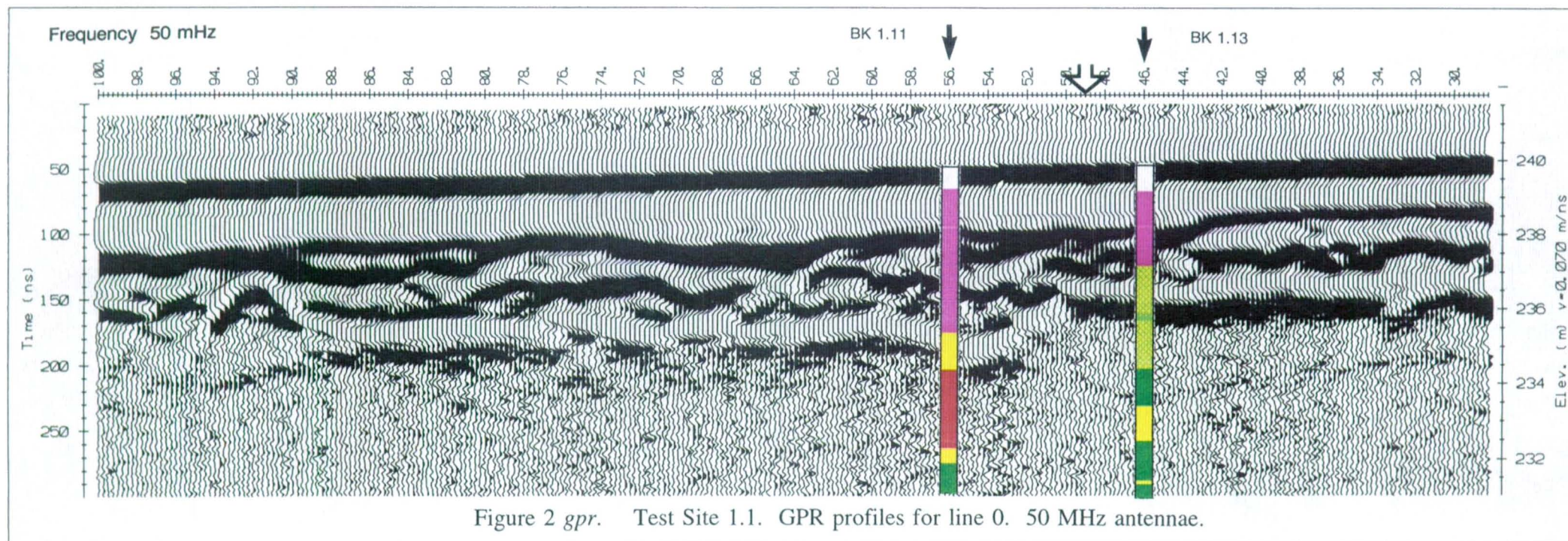
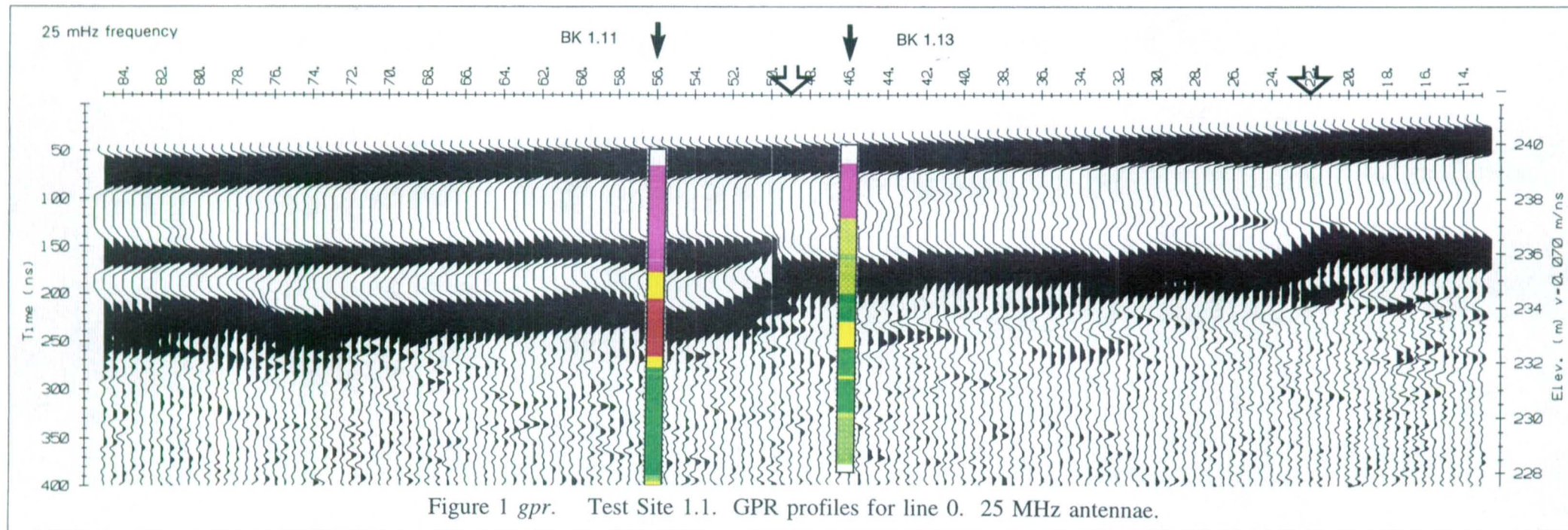


BK 1.11



BK 1.13

Figure 6. Test Site 1.1. Geological section: boreholes BK1.11, BK1.12, and BK1.13.



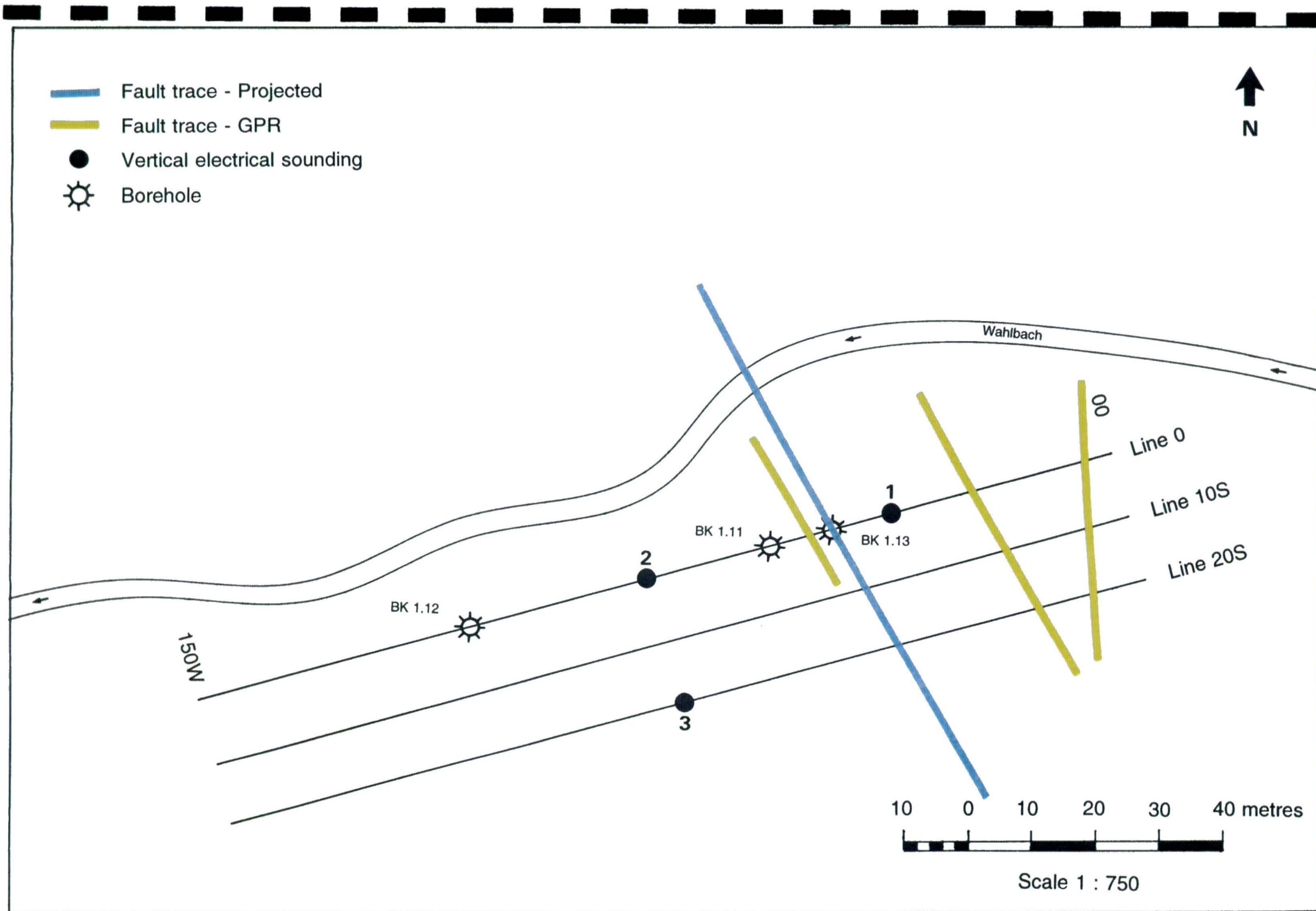


Figure 5. Test Site 1.1. Geophysical grid, borehole locations, and interpretation.

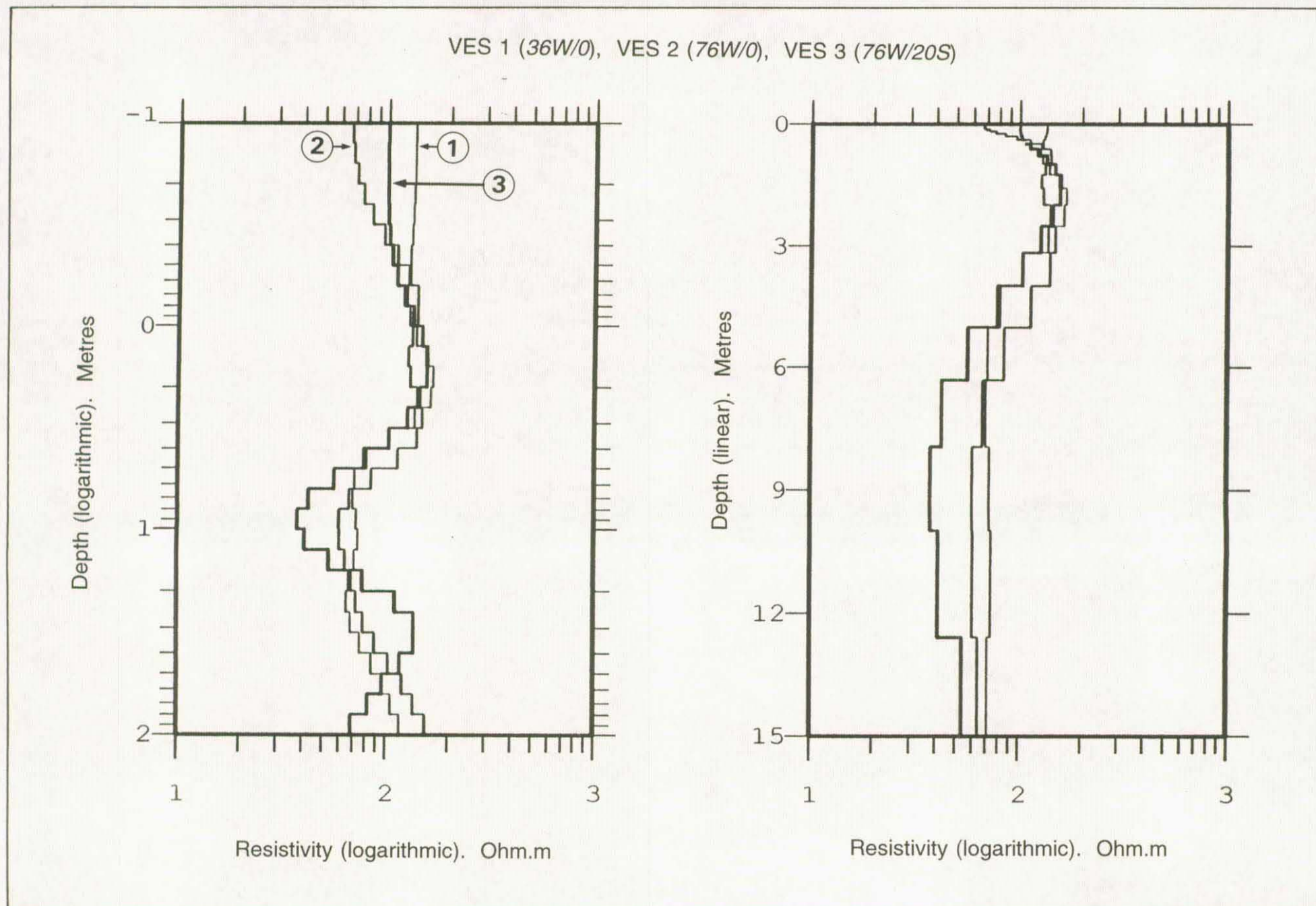
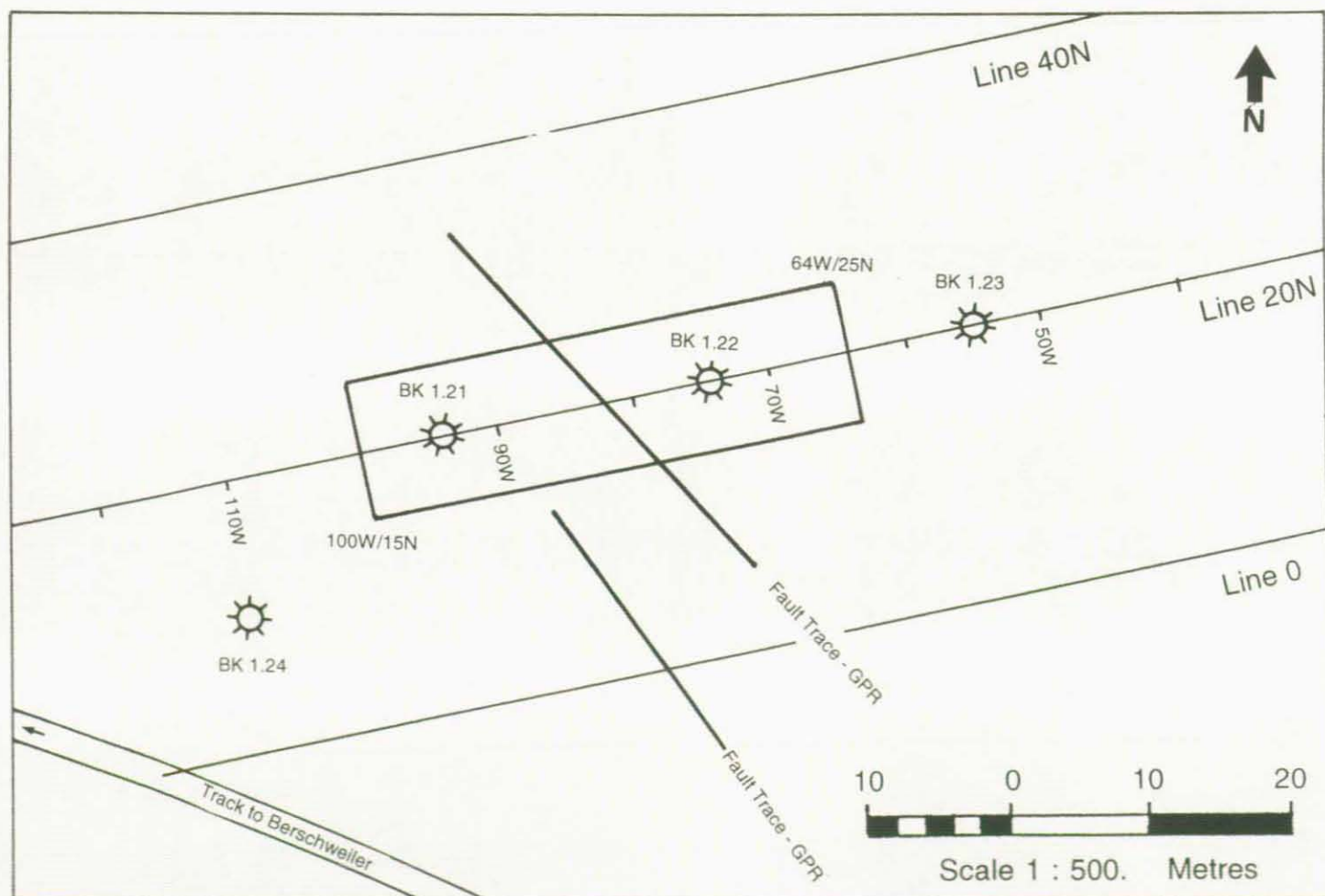
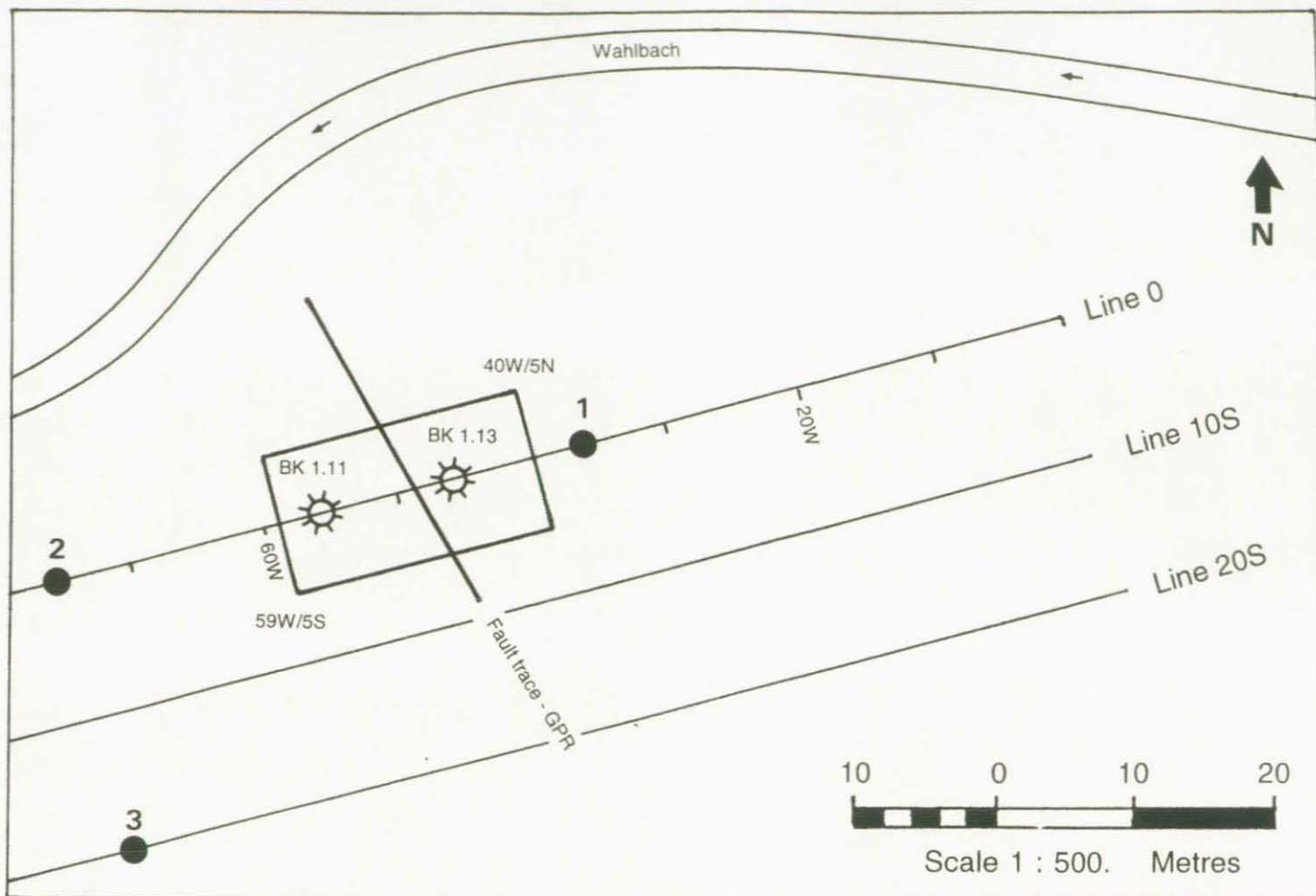


Figure 2 res.

Test Site 1.1. Interpretation of VES 1, 2, and 3.



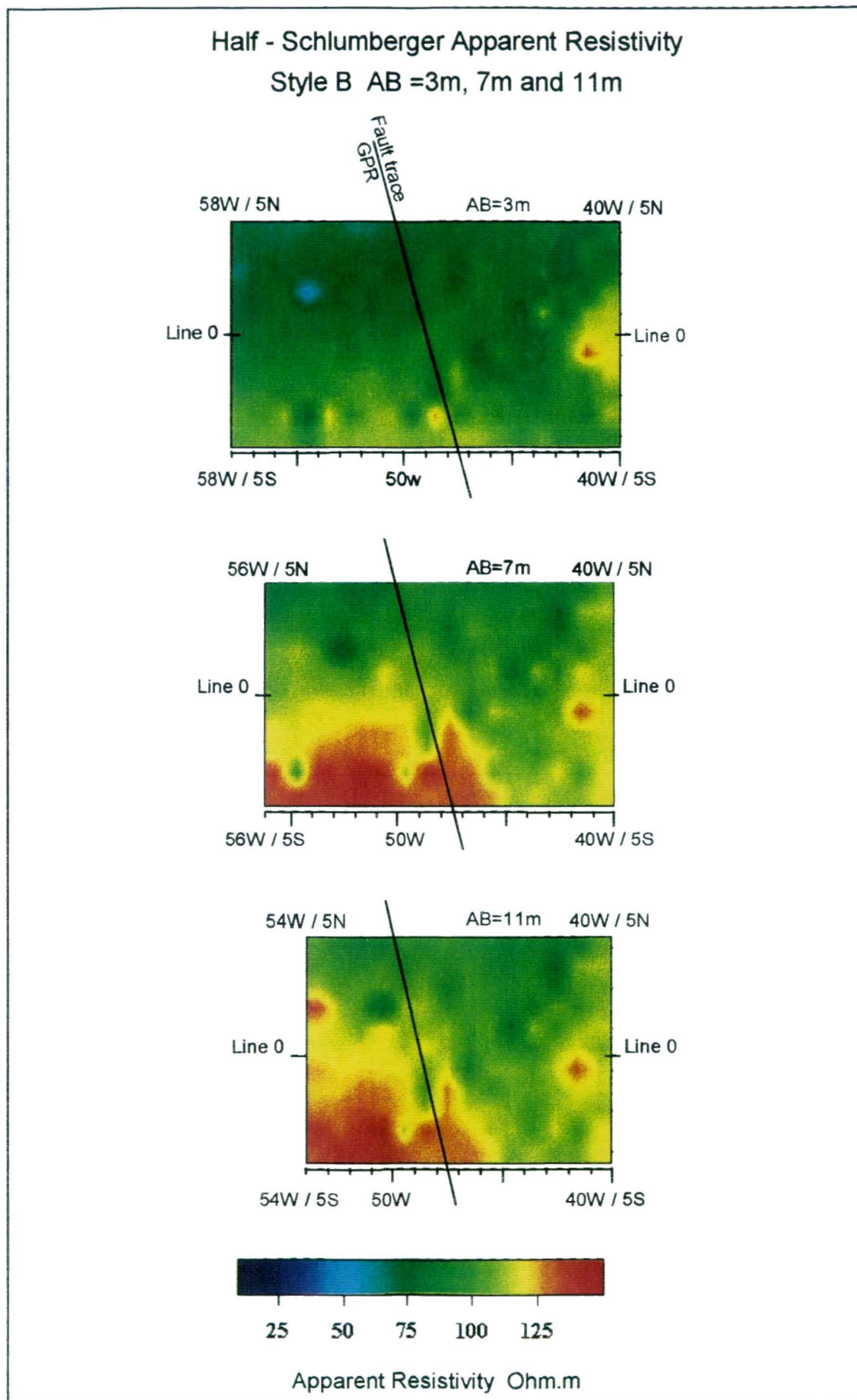


Figure 10 *rsc.* Test Site 1.1. Apparent resistivity data, showing projected position of the fault.

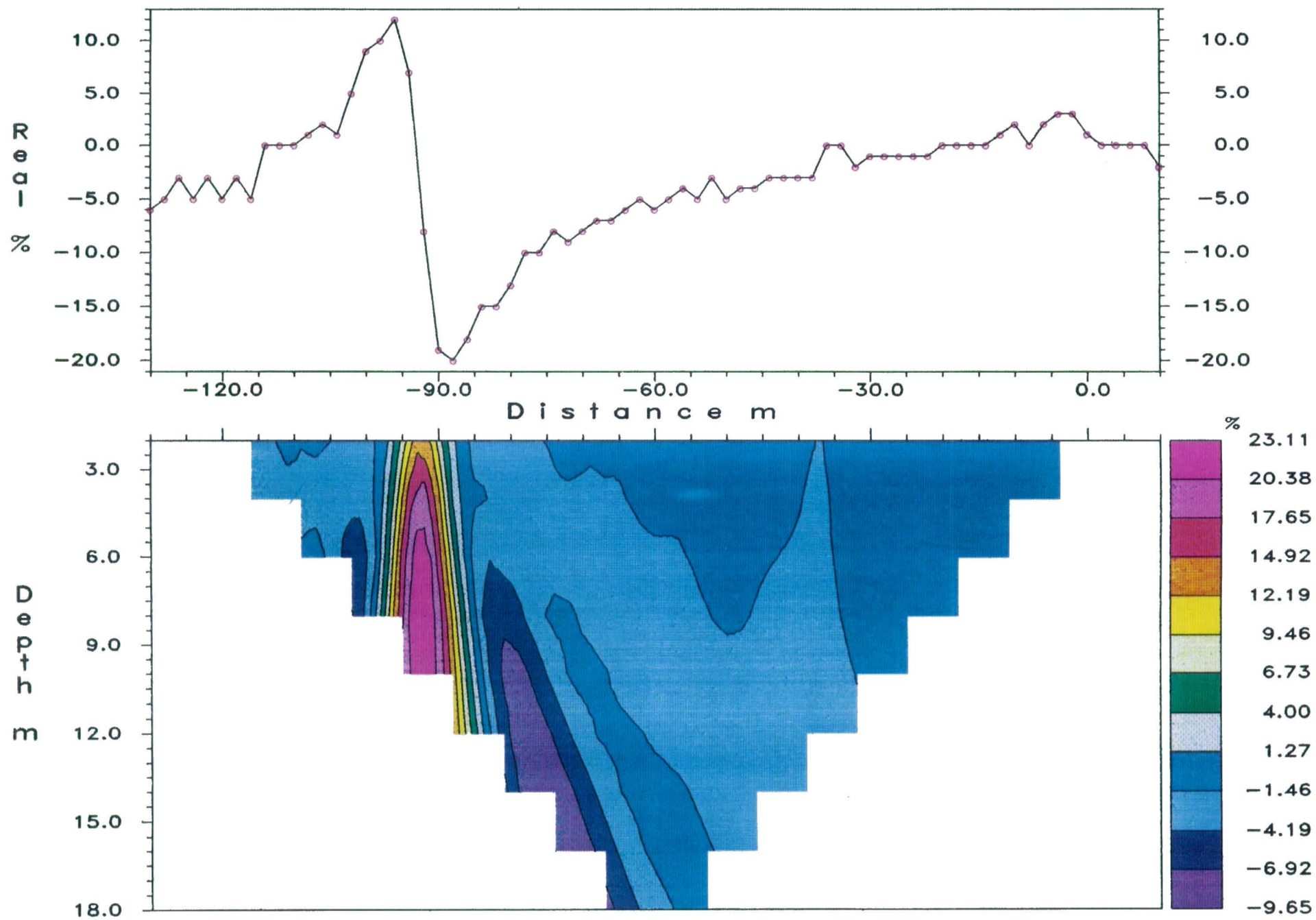
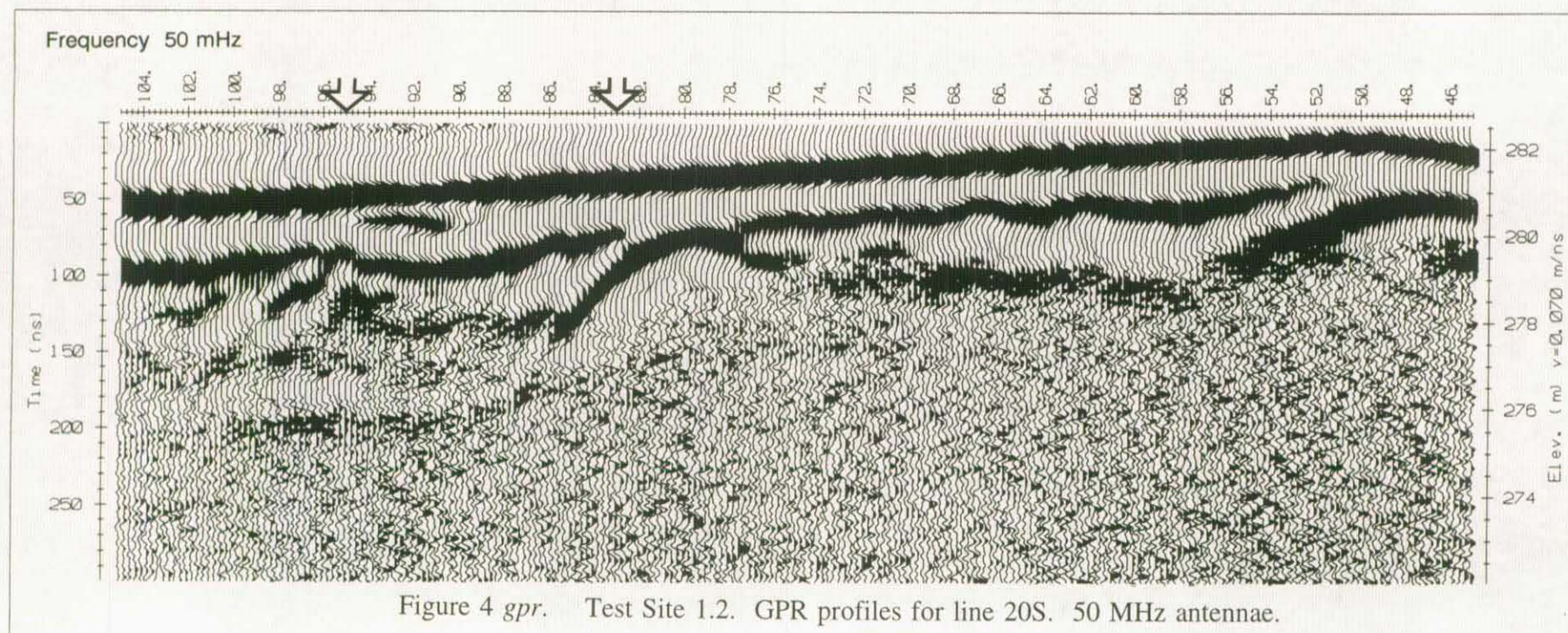
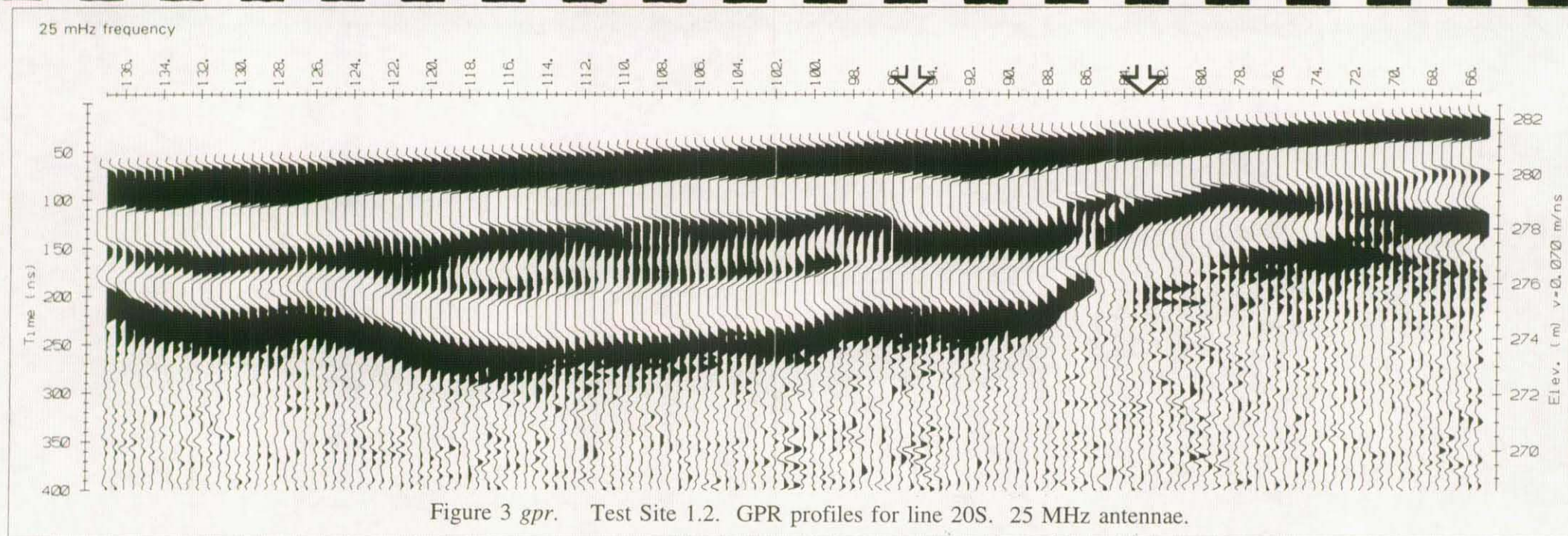


Figure 19 *vlf*. Test Site 1.1. Line 10S. Karous-Hjelt filtering of VLF M-field response over cultural feature.



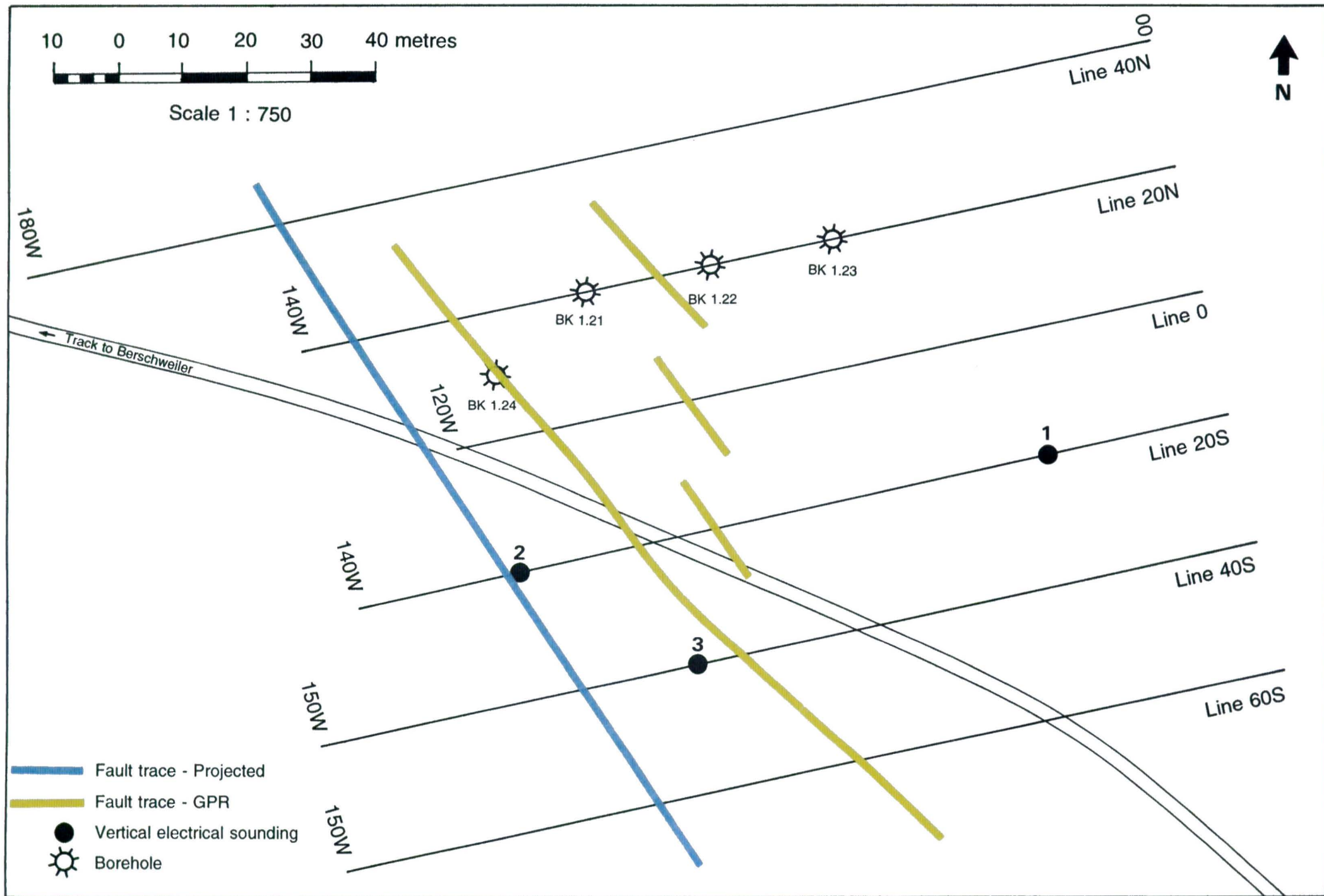


Figure 7. Test Site 1.2. Geophysical grid, borehole locations, and interpretation.

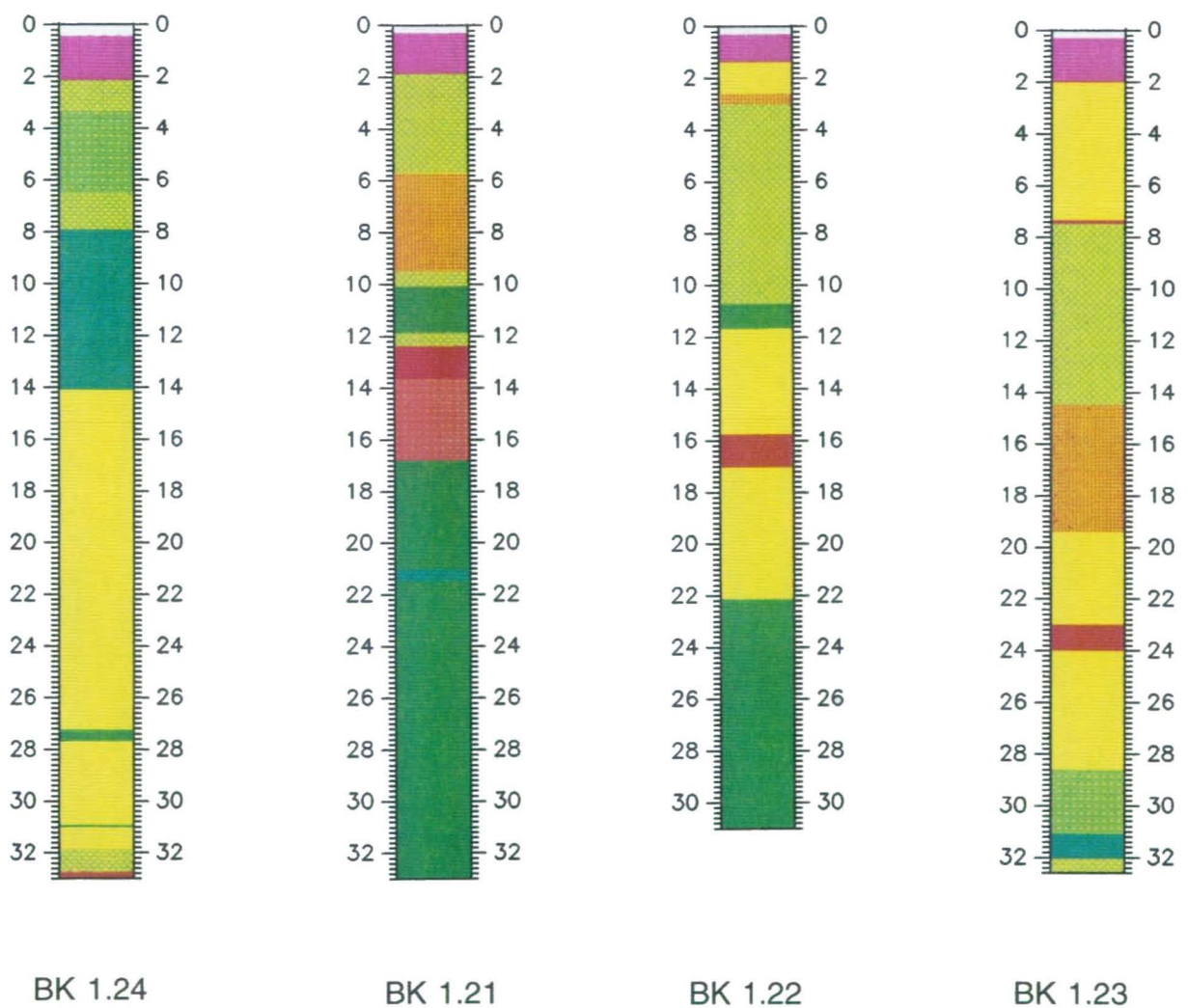


Figure 8. Test Site 1.2. Geological section: boreholes BK1.21, BK1.22, BK1.23 and BK1.24.

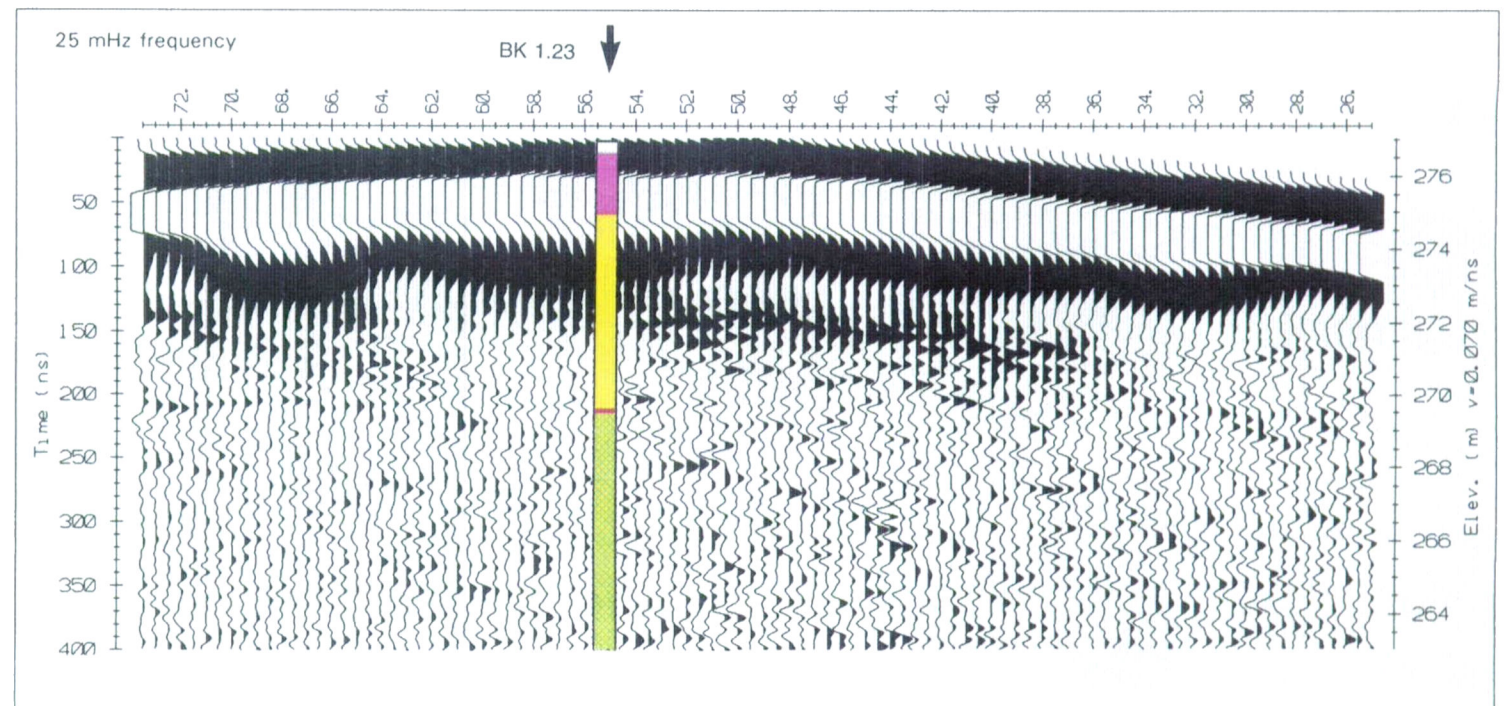
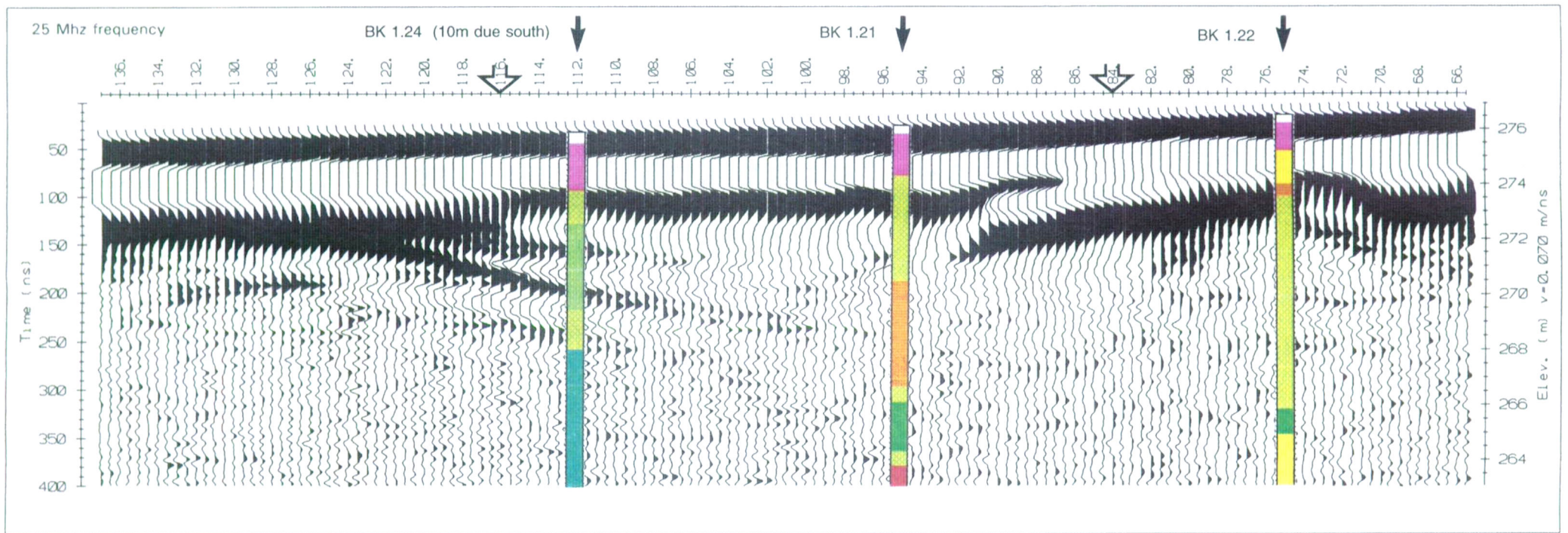


Figure 5 *gpr*. Test Site 1.2. GPR profiles for line 20N. 25 MHz antennae.

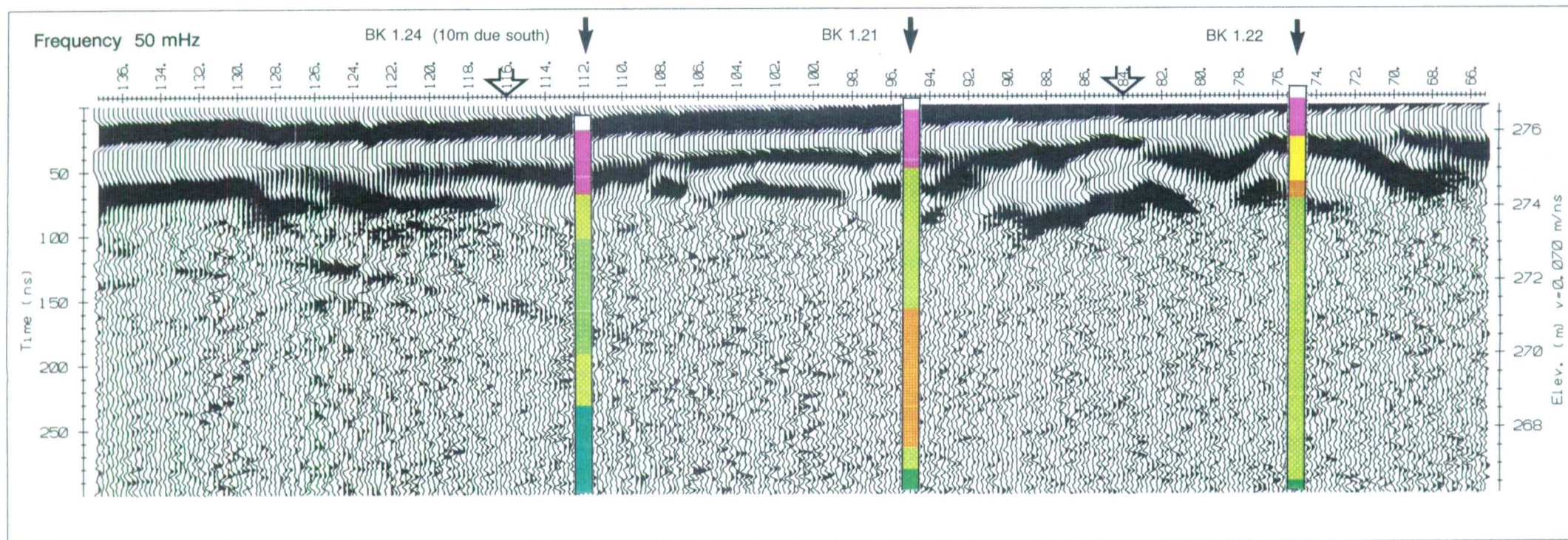


Figure 6 gpr. Test Site 1.2. GPR profiles for line 20N. 50 MHz antennae.

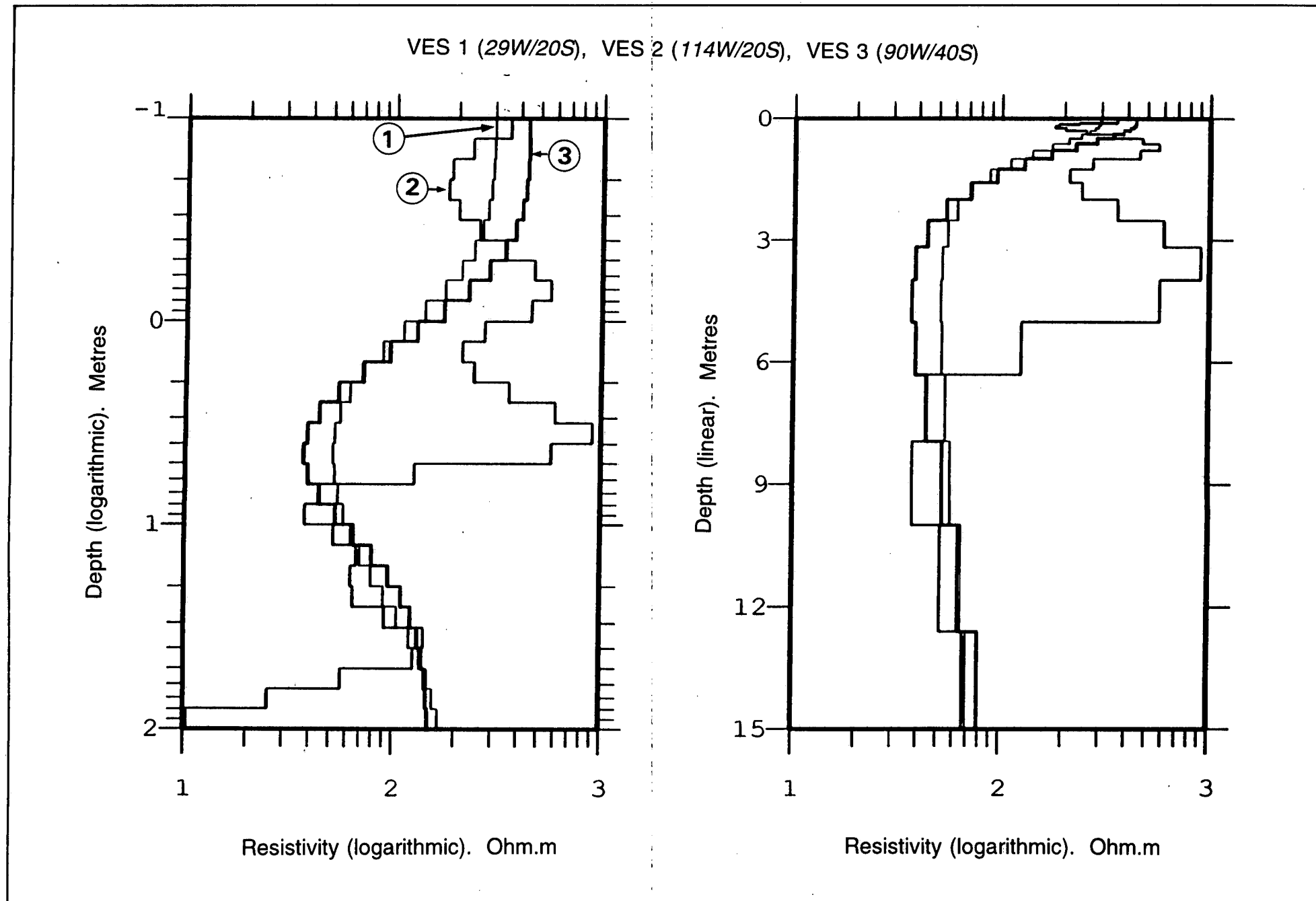


Figure 3 res.

Test Site 1.2. Interpretation of VES 1, 2, and 3.

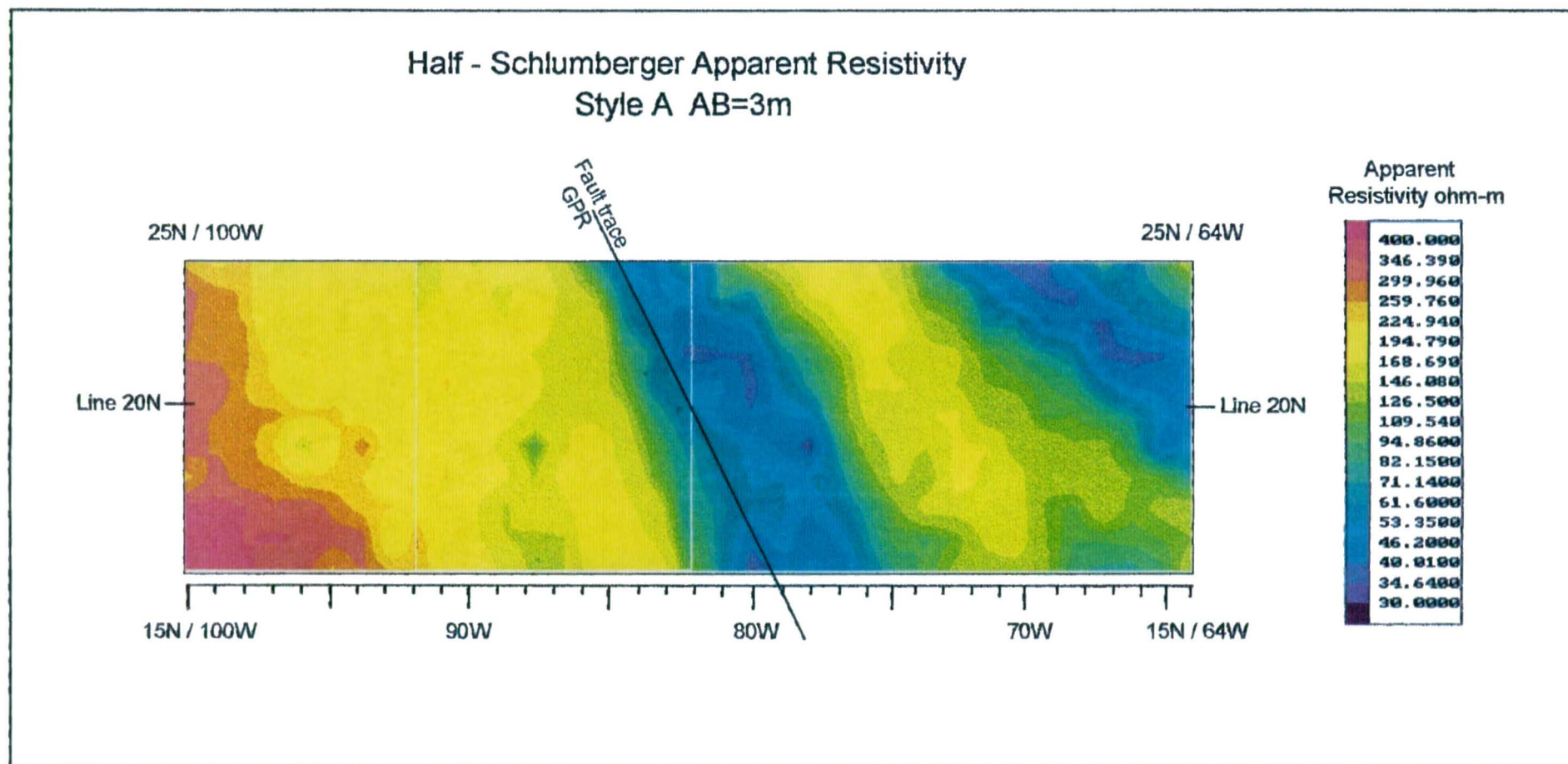


Figure 7 *rsc.* Test Site 1.2. RESCAN apparent resistivity maps for three overlapping sections.

Site 1.2 a, b & c: Averaged overlaps

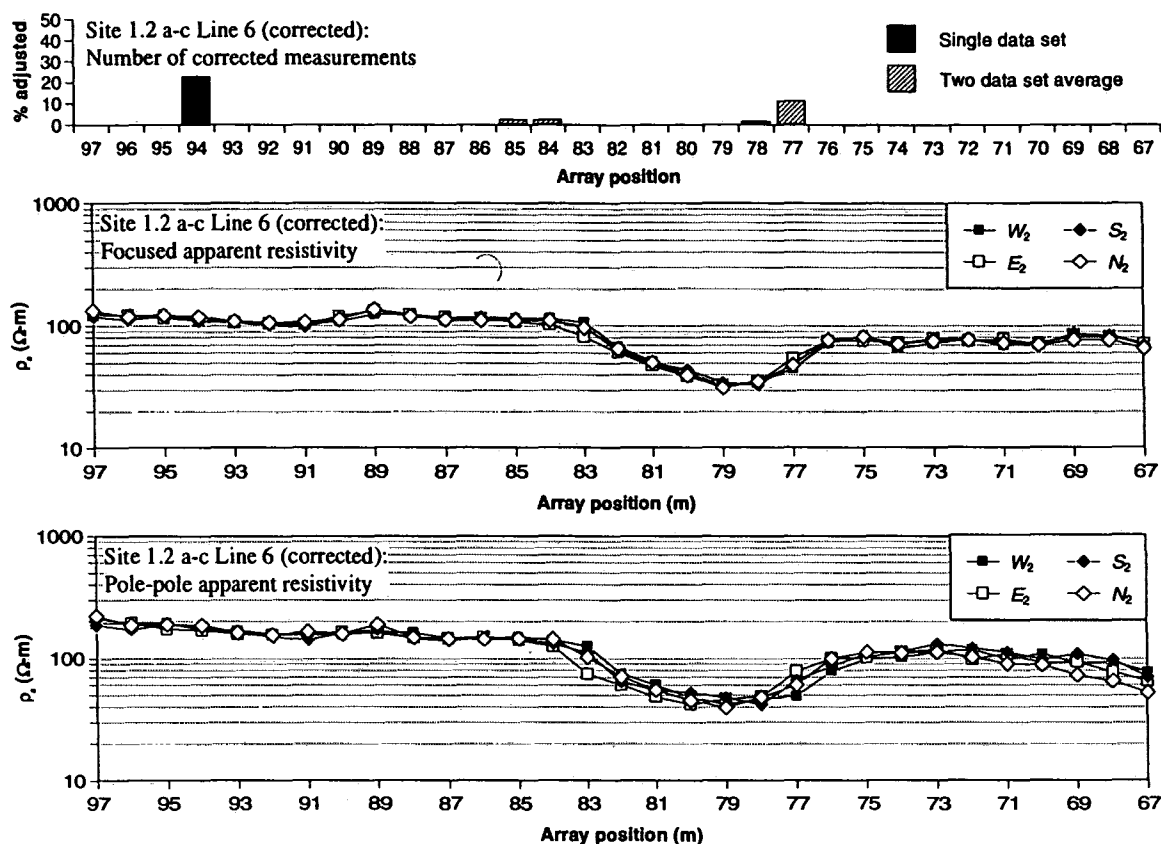


Figure 27 *rsc.* Test Site 1.2. Grids a, b, and c. Apparent resistivity traverse.

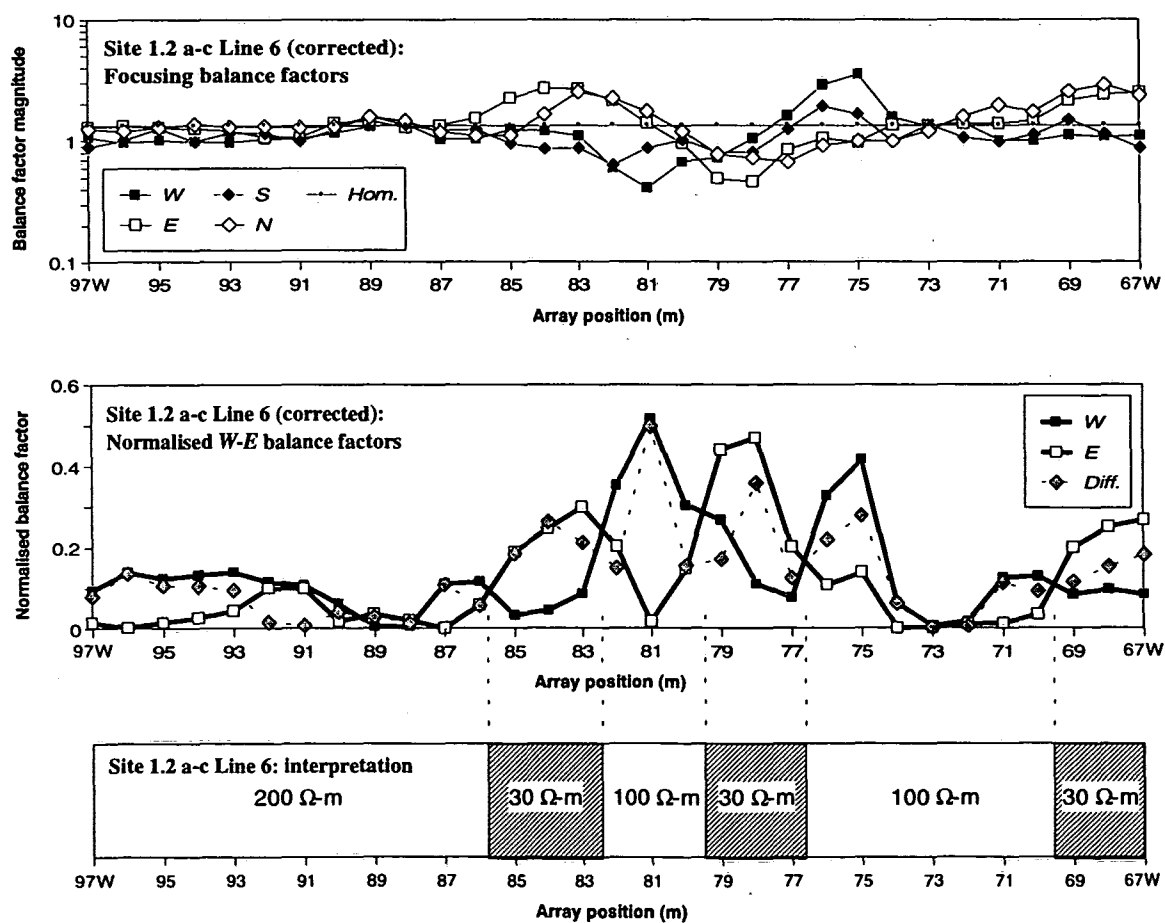


Figure 28 *rsc.* Test Site 1.2. Grids a, b, and c. Focussing balance factors.

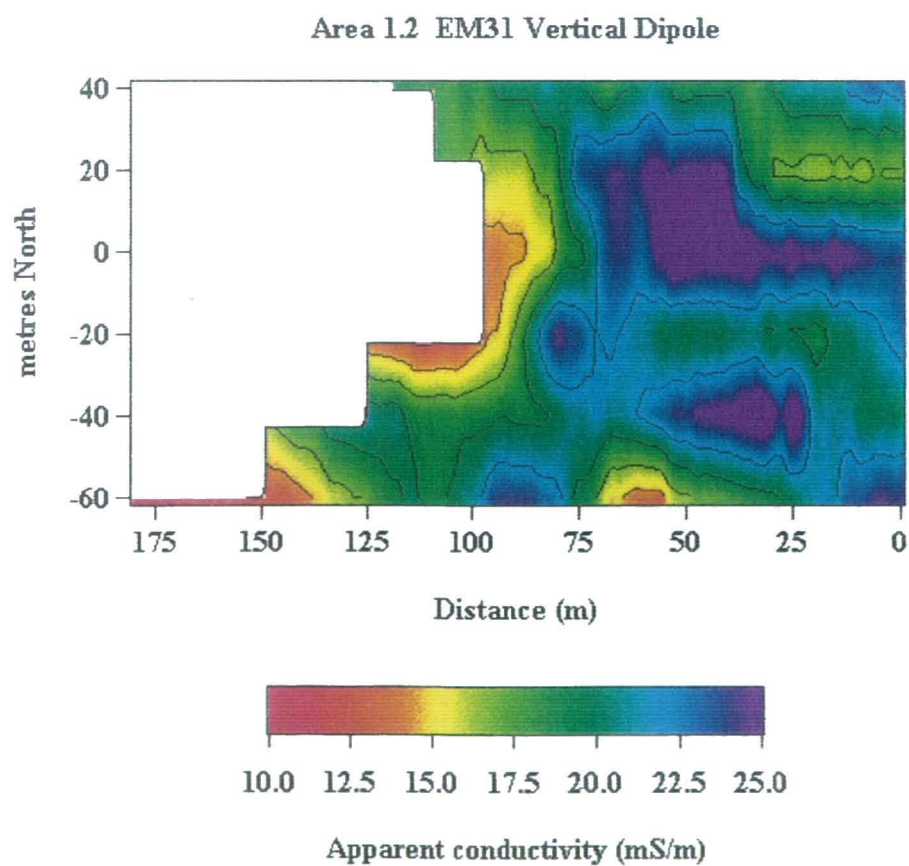
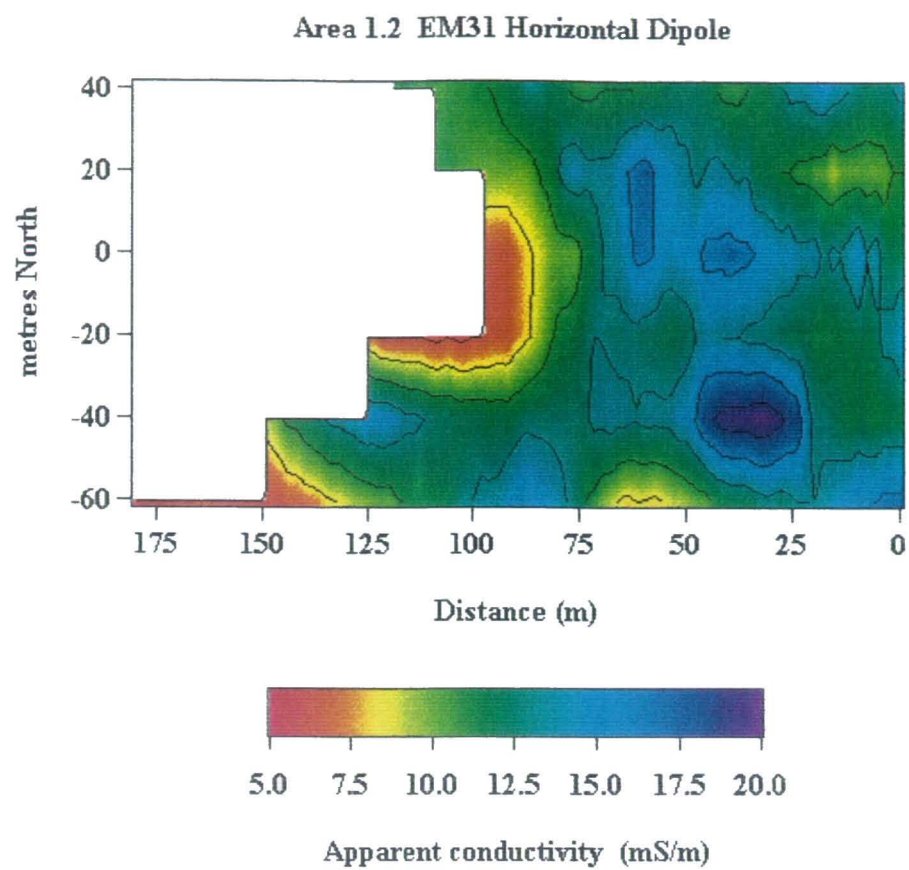


Figure 1 *em.* Test Site 1.2. Horizontal and vertical dipole conductivity contours.

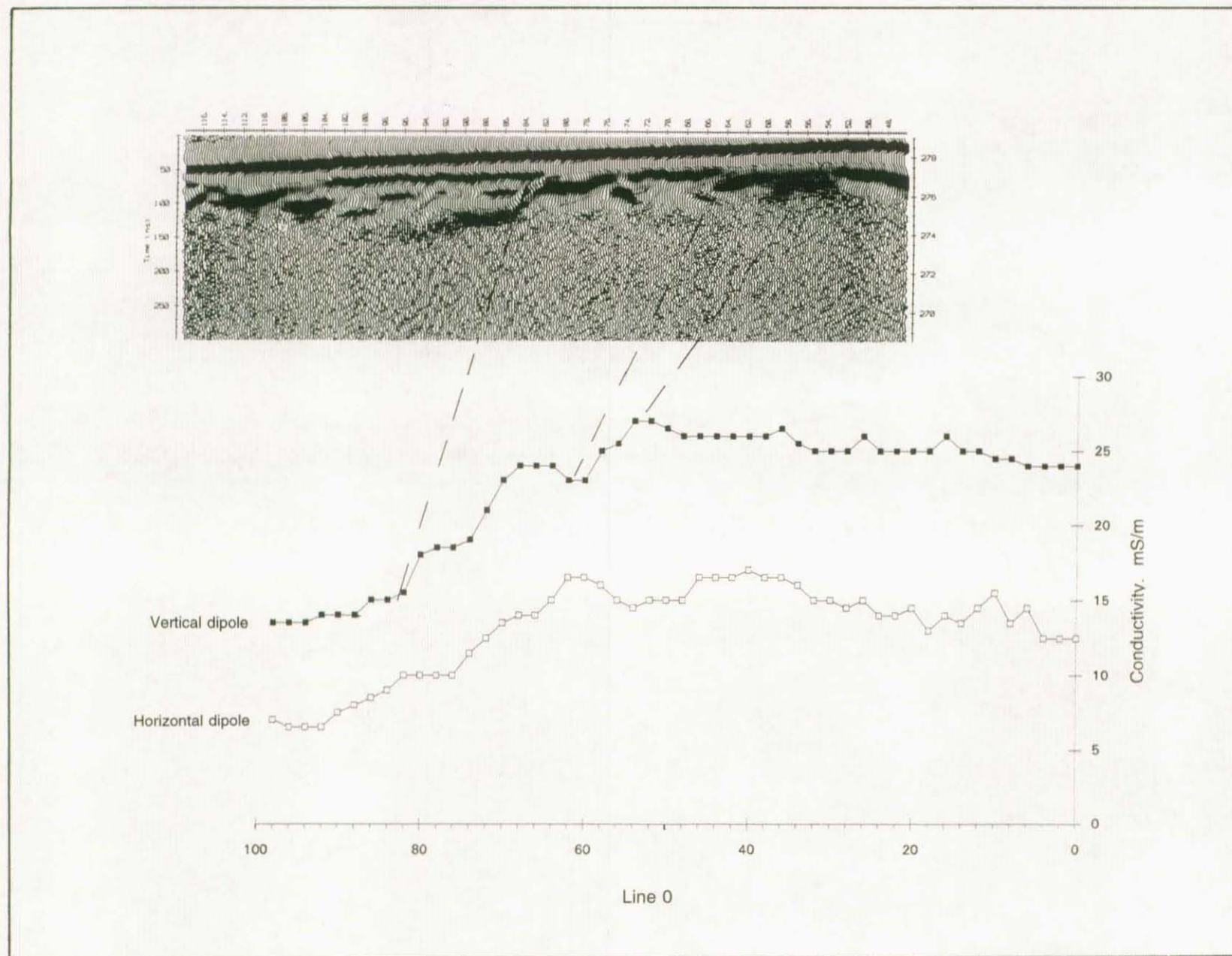


Figure 2 em. Test site 1.2. Composite horizontal and vertical dipole conductivity and GPR section for line 0.

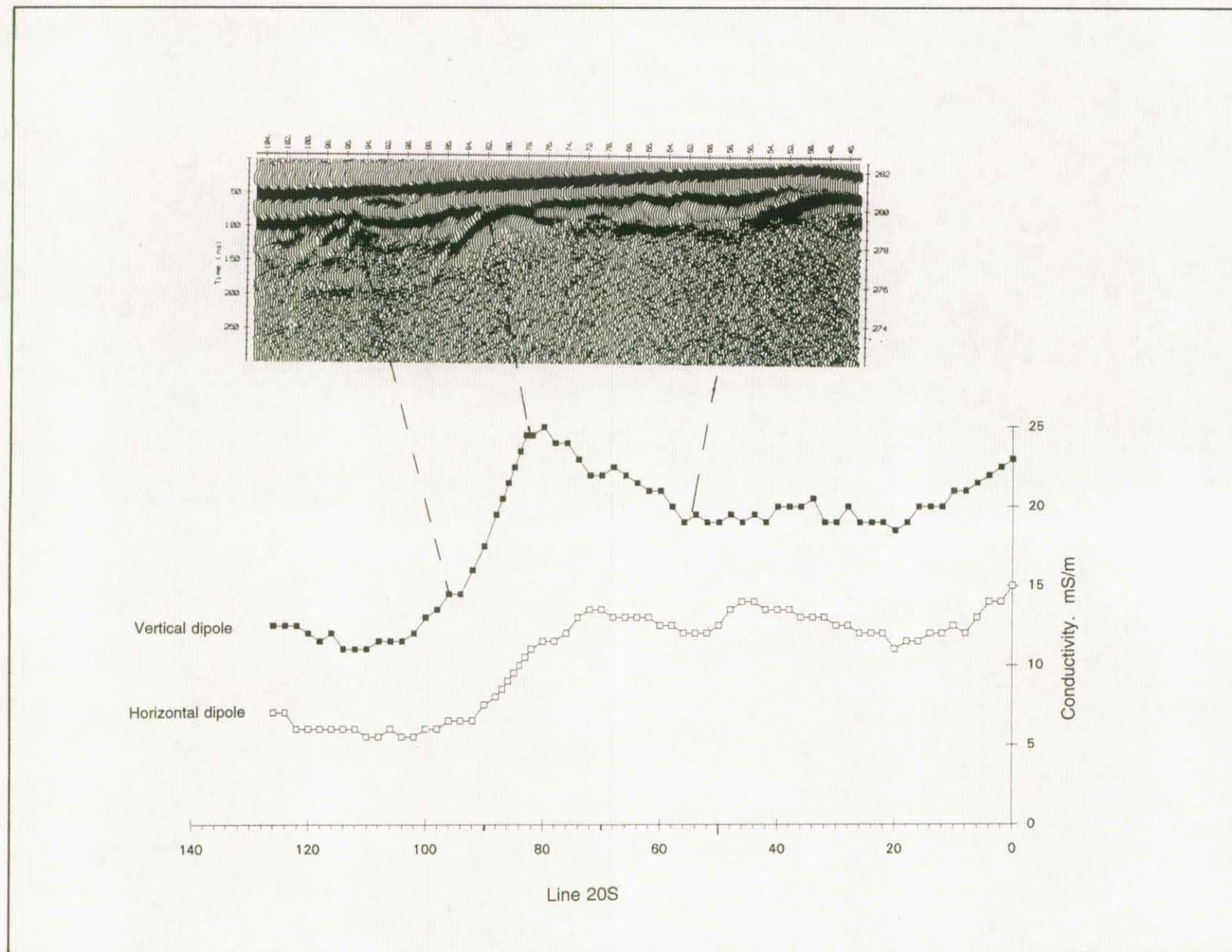


Figure 3 *em*. Test Site 1.2. Composite horizontal and vertical dipole conductivity and GPR section for line 20S.

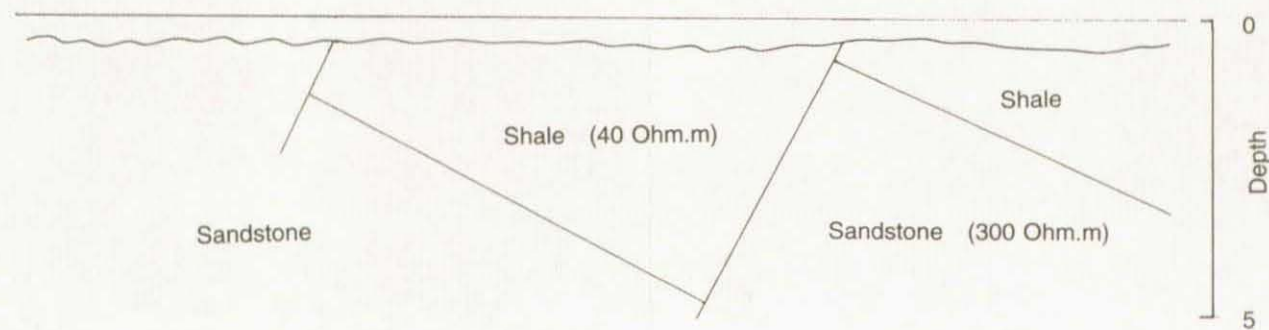
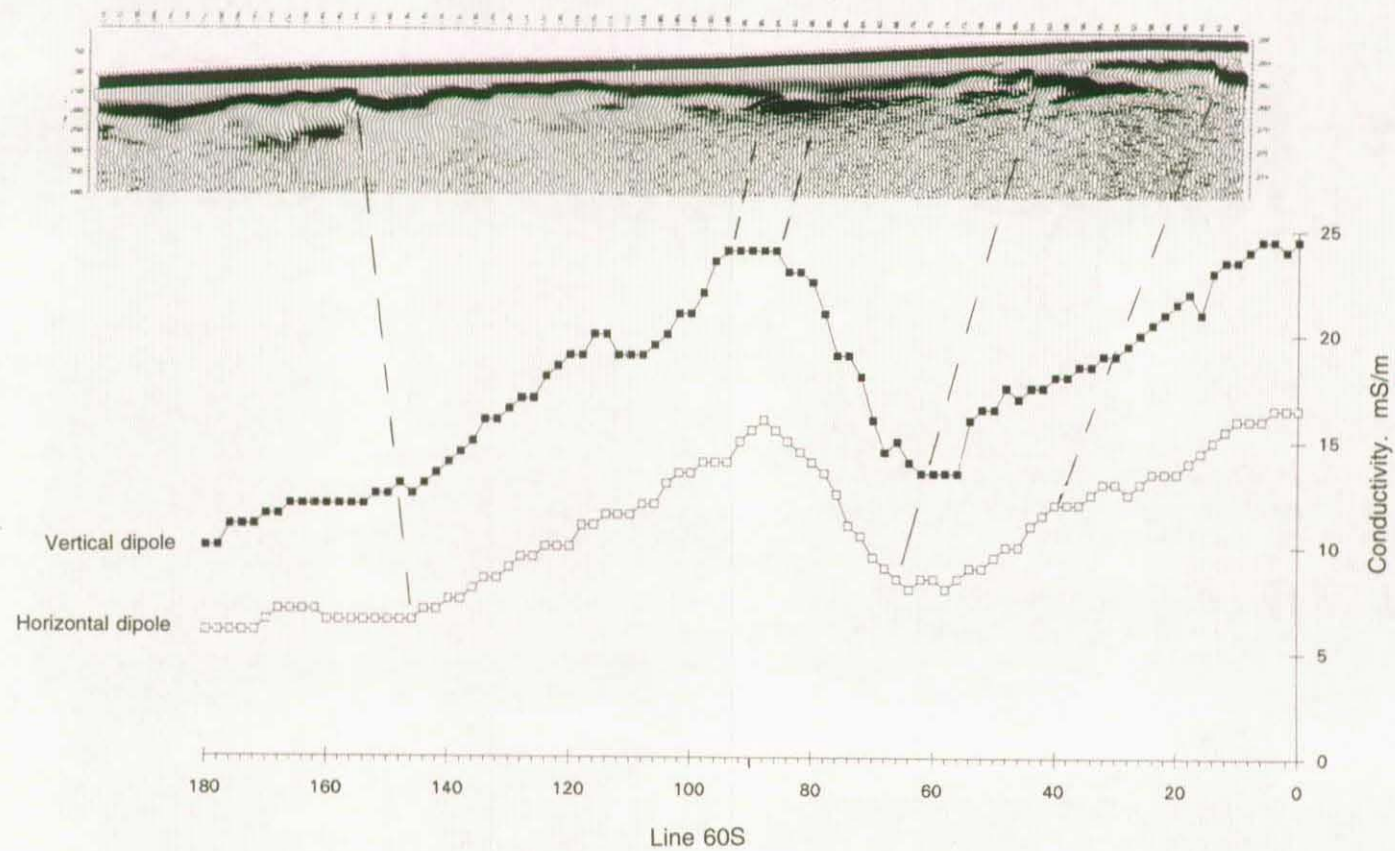


Figure 4 *em.* Test Site 1.2. Composite horizontal and vertical dipole conductivity and GPR section for line 60S and possible geological section.

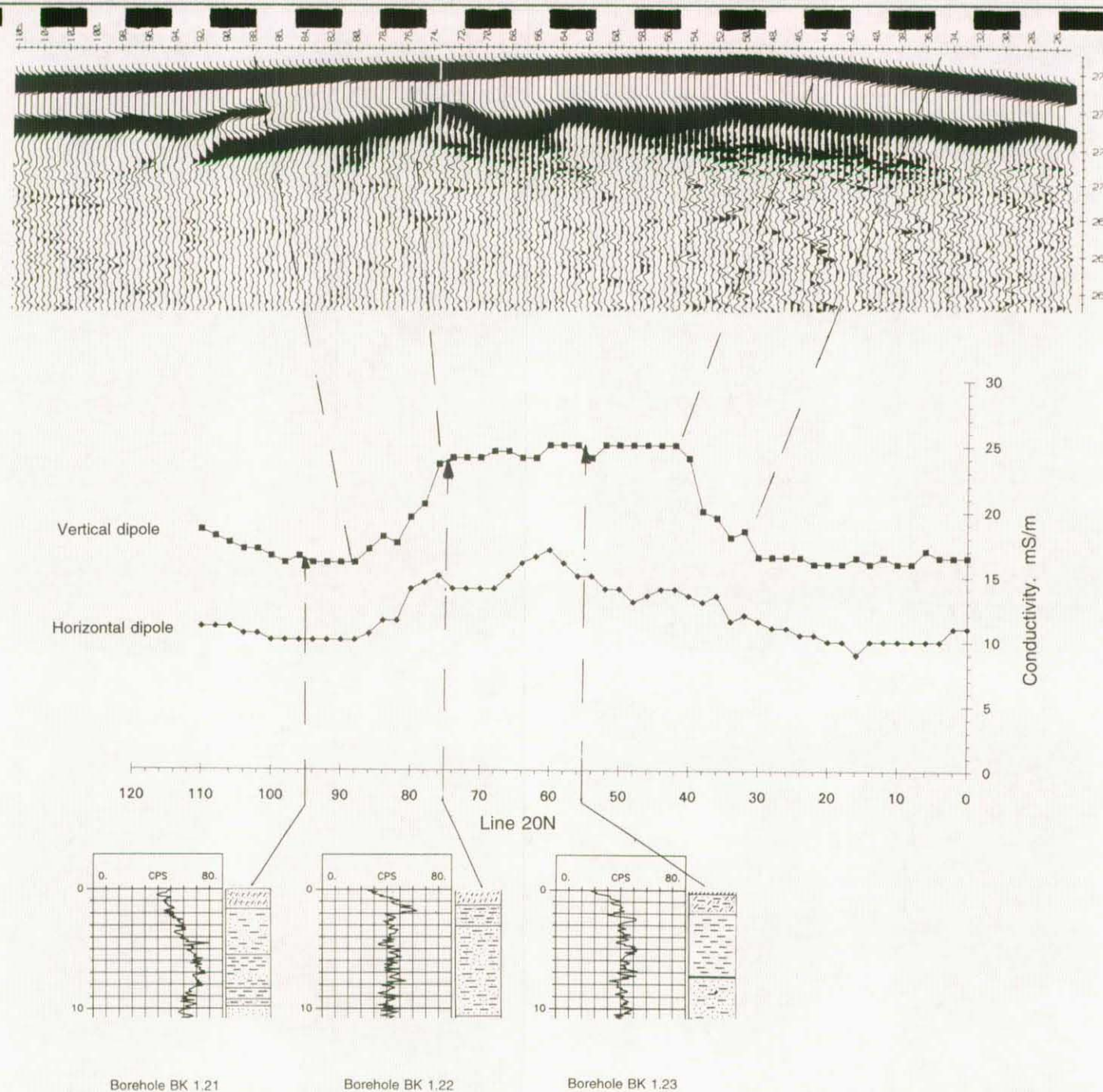


Figure 5 *em*. Test Site 1.2. Composite horizontal and vertical dipole conductivity and GPR section for line 20N and proven geology.

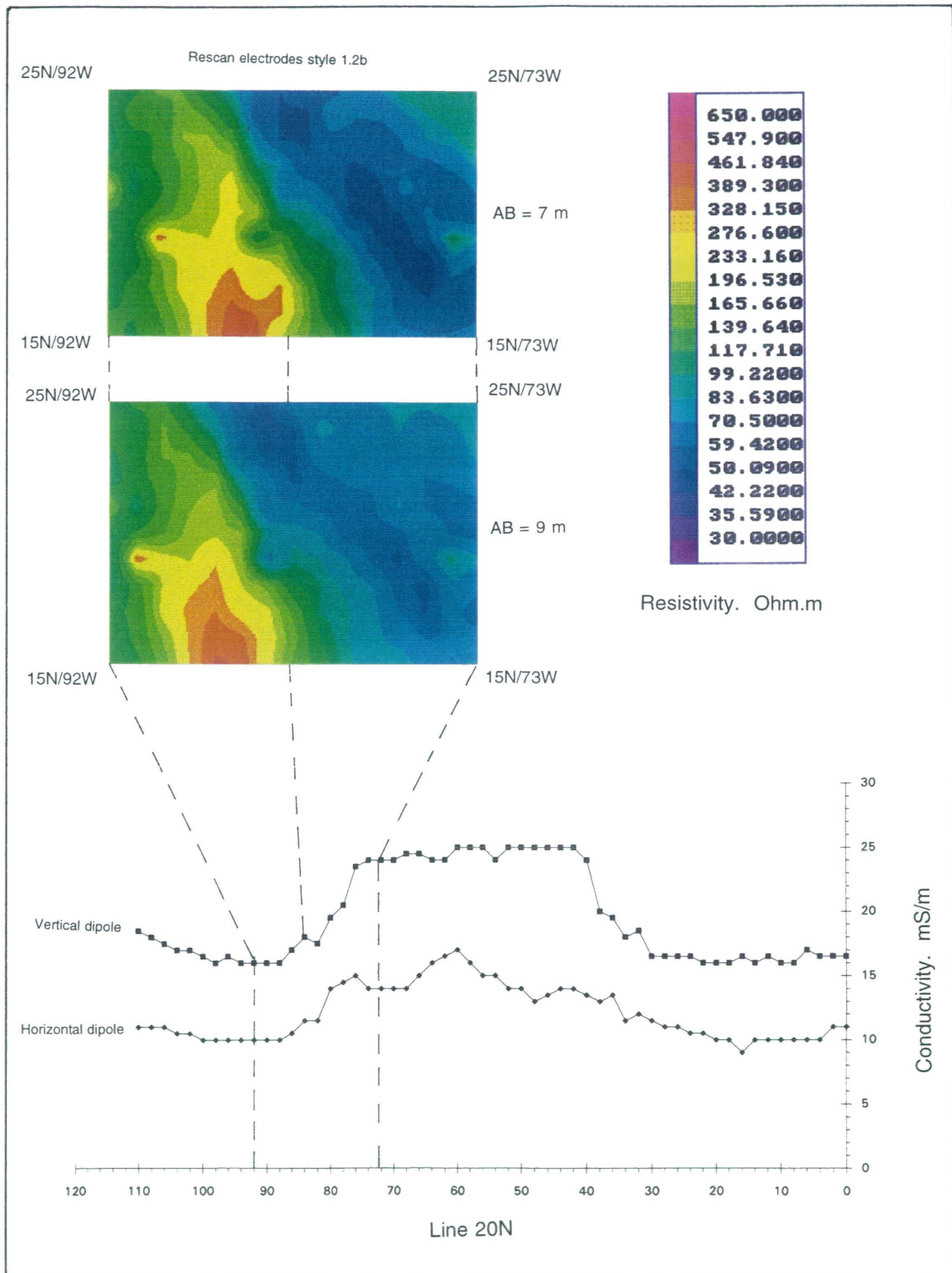
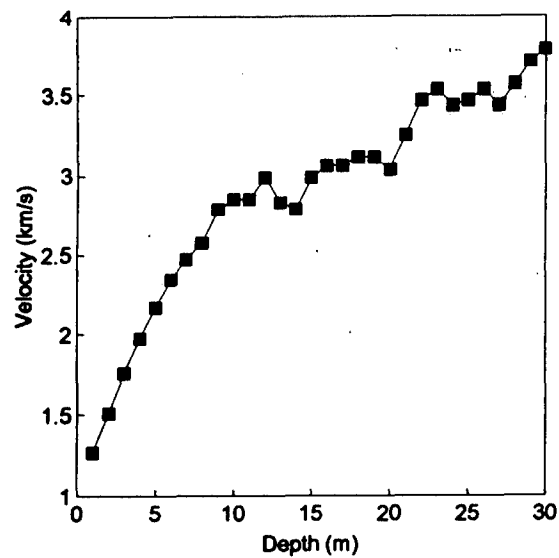
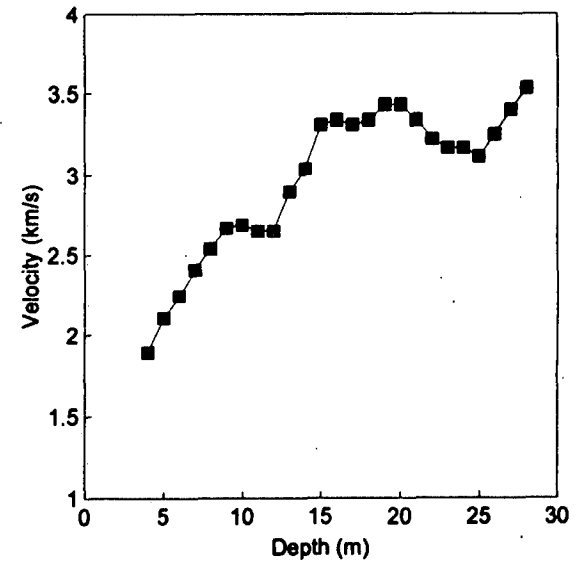


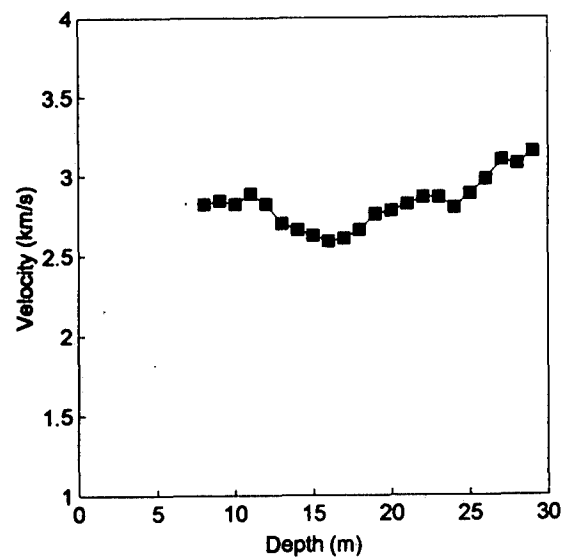
Figure 6 em. Test Site 1.2. Composite of conductivity profiles and Rescan images of part of line 20N.



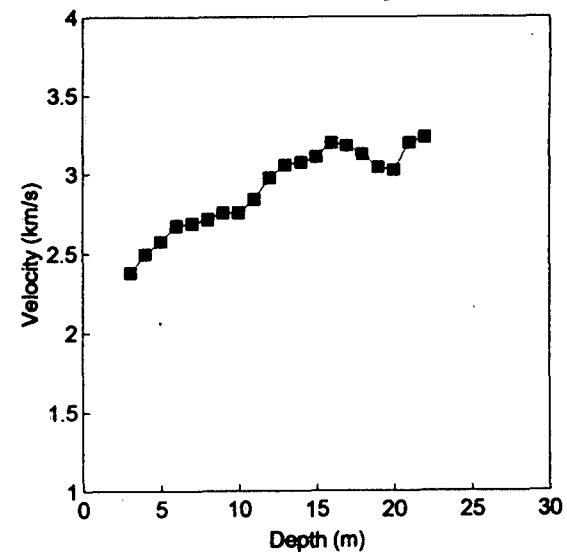
Test Site 1.2. Setup BK1.22/BK1.23



Test Site 1.2. Setup BK1.21/BK1.22



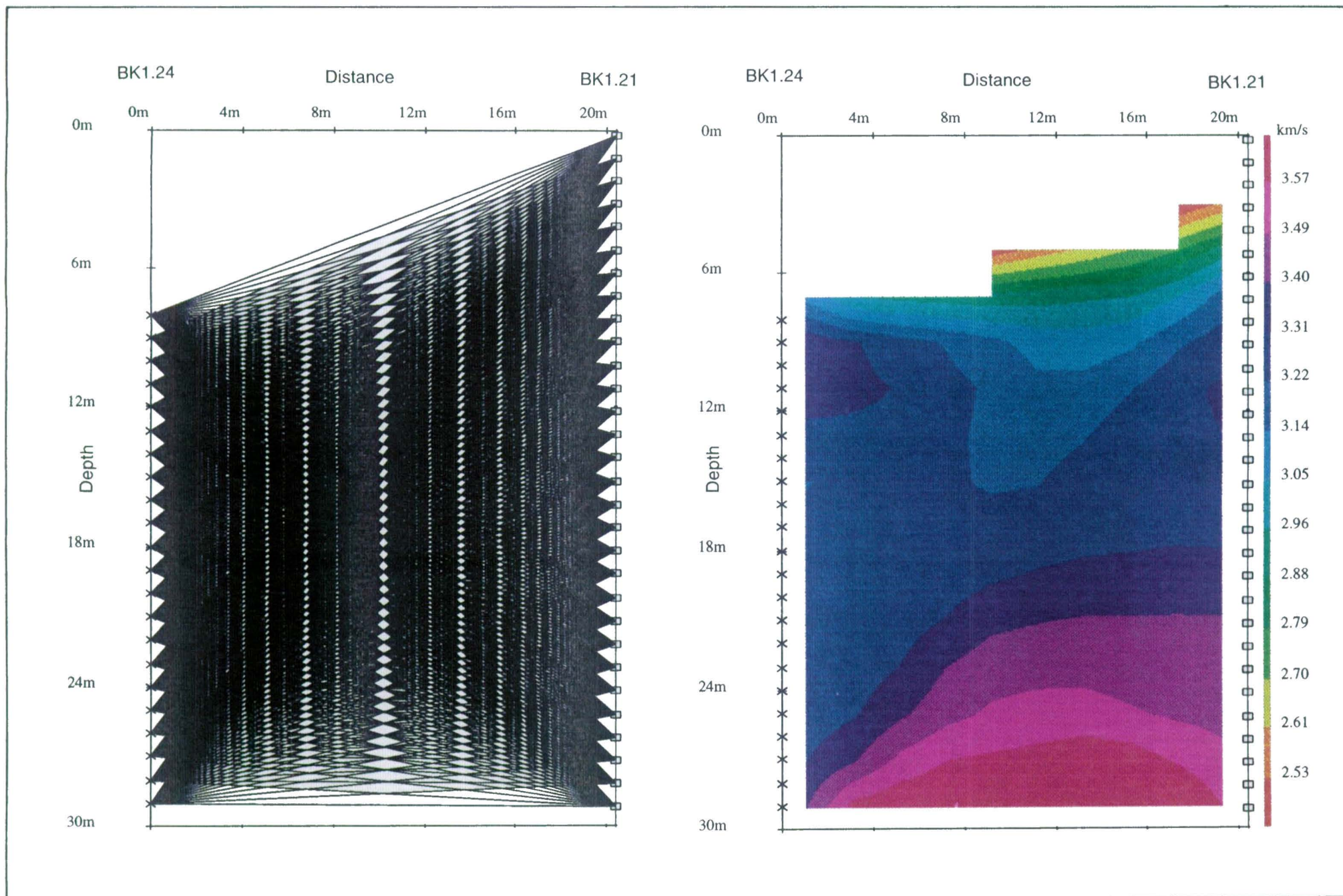
Test Site 1.2. Setup BK1.24/BK1.21



Test Site 1.4. Setup BK1.43/BK1.44

Figure 1 *sei*.

Test Sites 1.2 and 1.4. Plots of horizontal velocity versus depth.



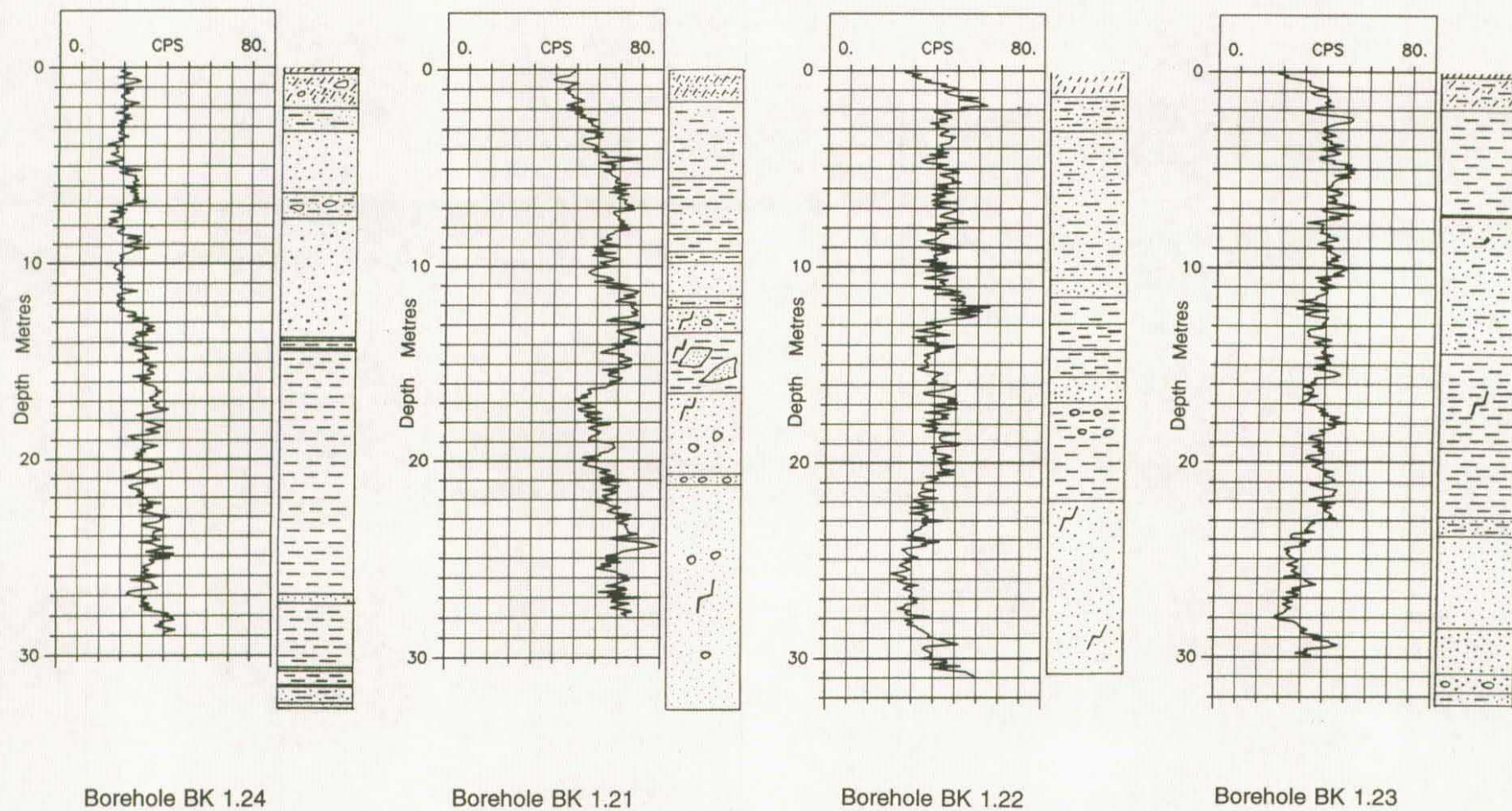


Figure 1 gam.

Test Site 1.2. Natural gamma logs for boreholes BK1.21 to BK1.24.

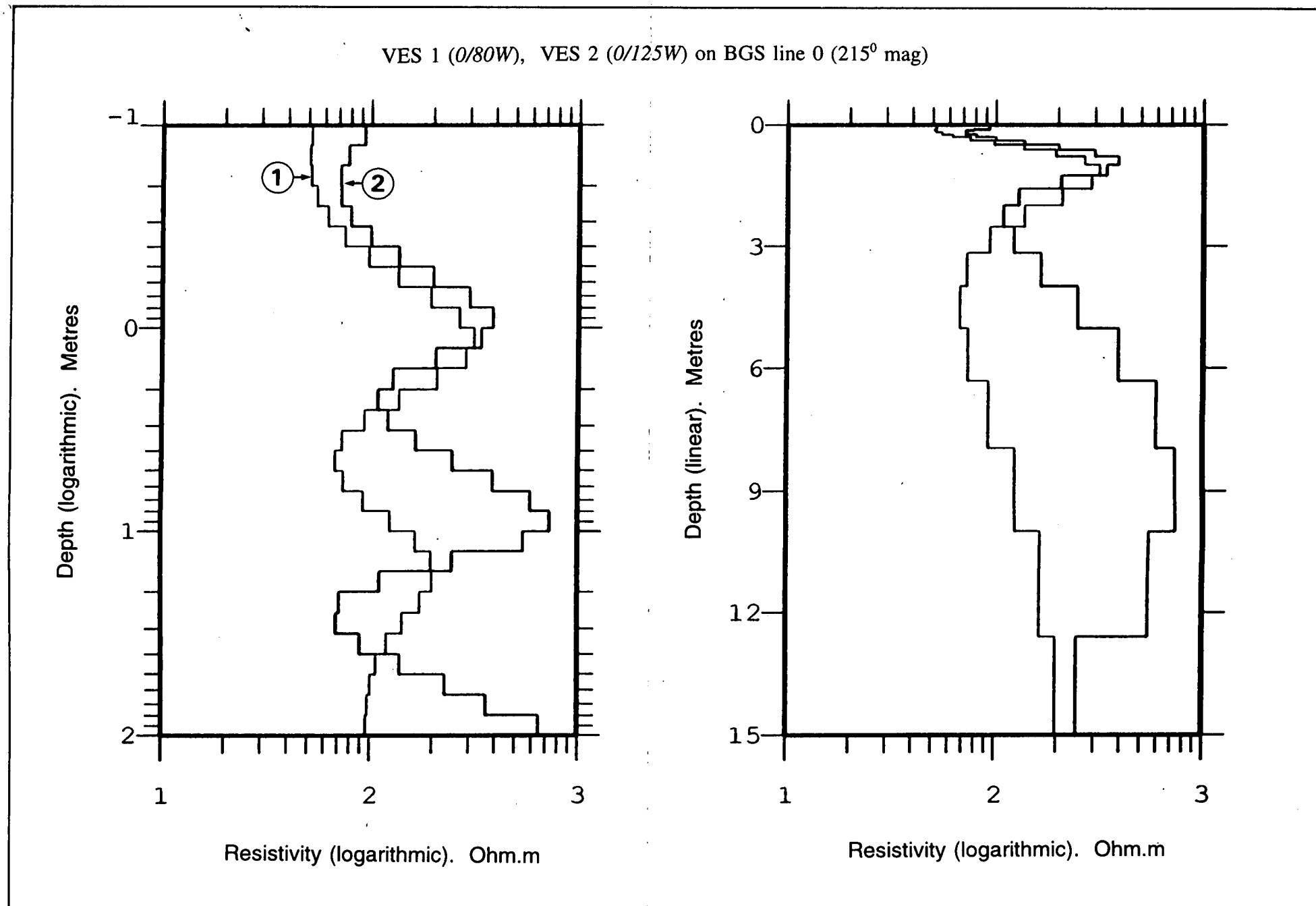


Figure 4 *res.*

Test Site 1.3. Interpretation of VES 1, and 2.

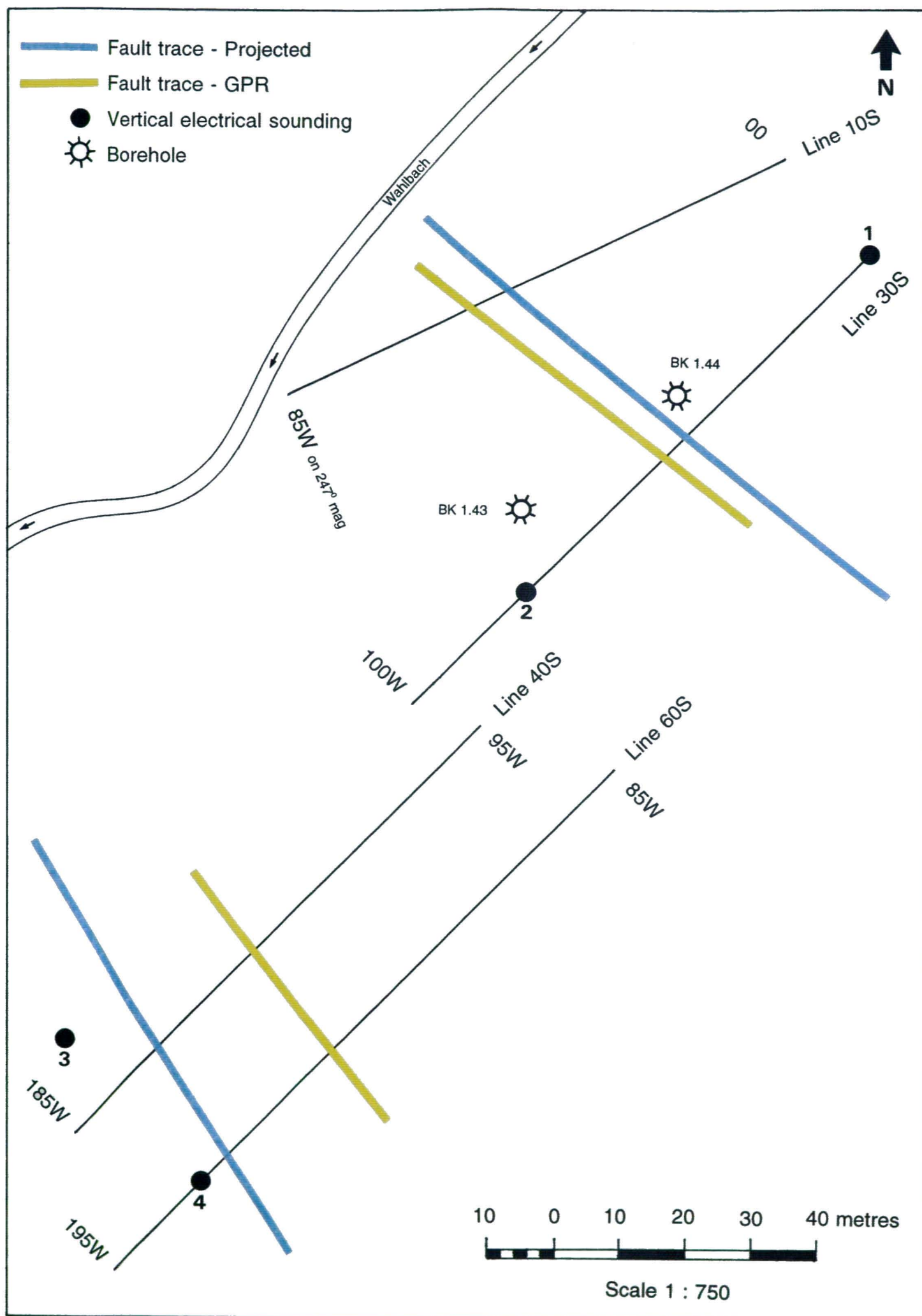


Figure 9. Test Site 1.4. Geophysical grid, borehole locations, and interpretation.

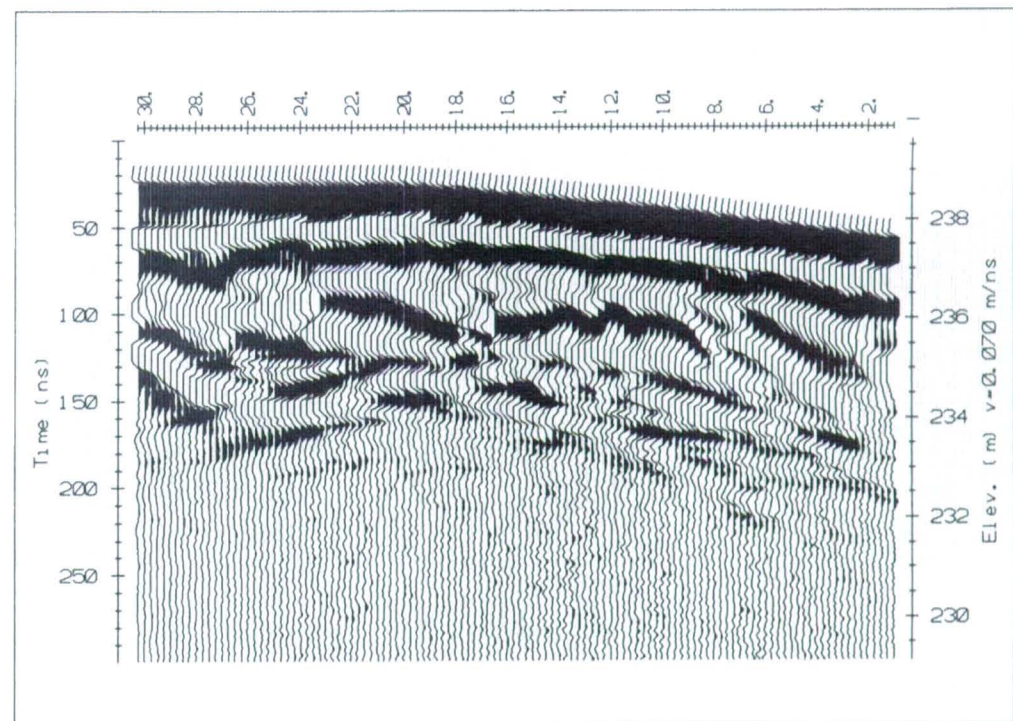
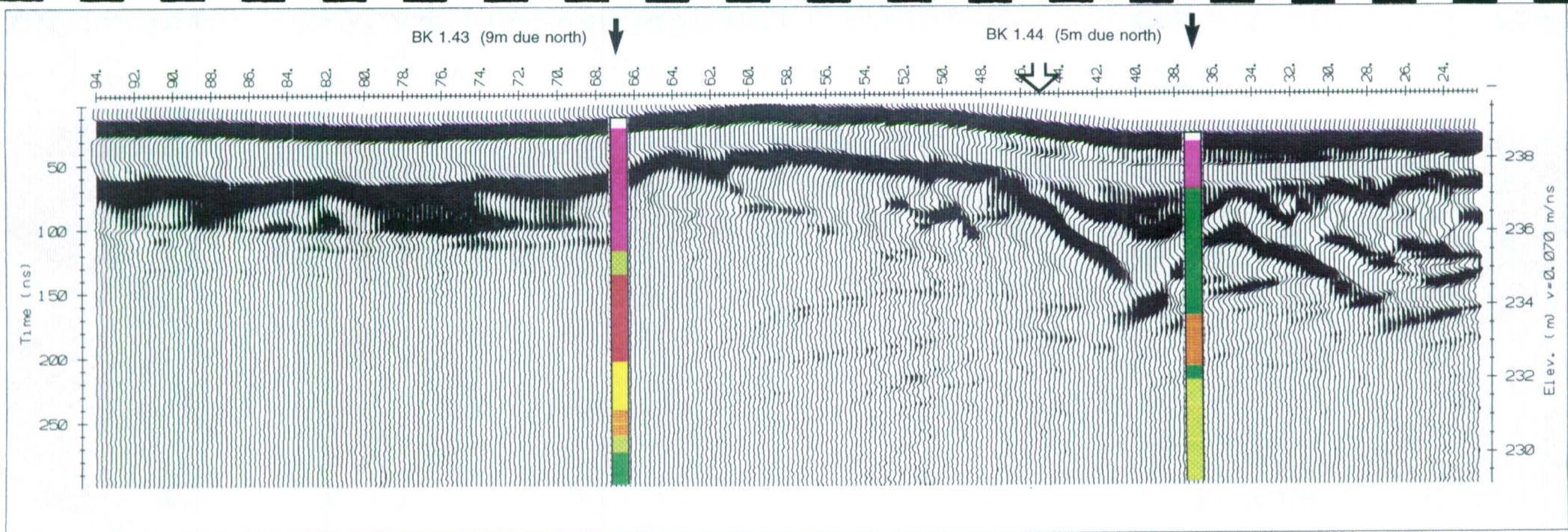
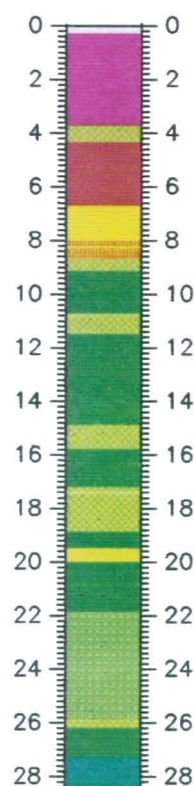
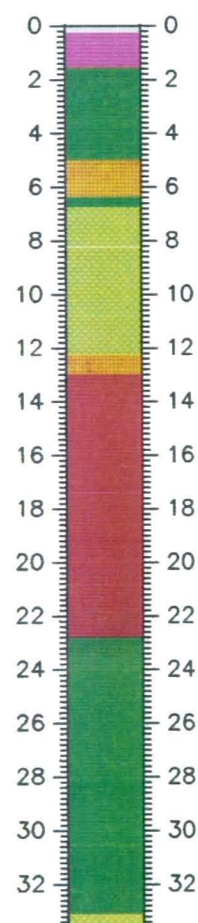


Figure 7 *gpr*. Test Site 1.4. GPR profile for line 30S. 50 MHz antennae.



BK 1.43



BK 1.44

Figure 10. Test Site 1.4. Geological section: boreholes BK1.43, BK1.44

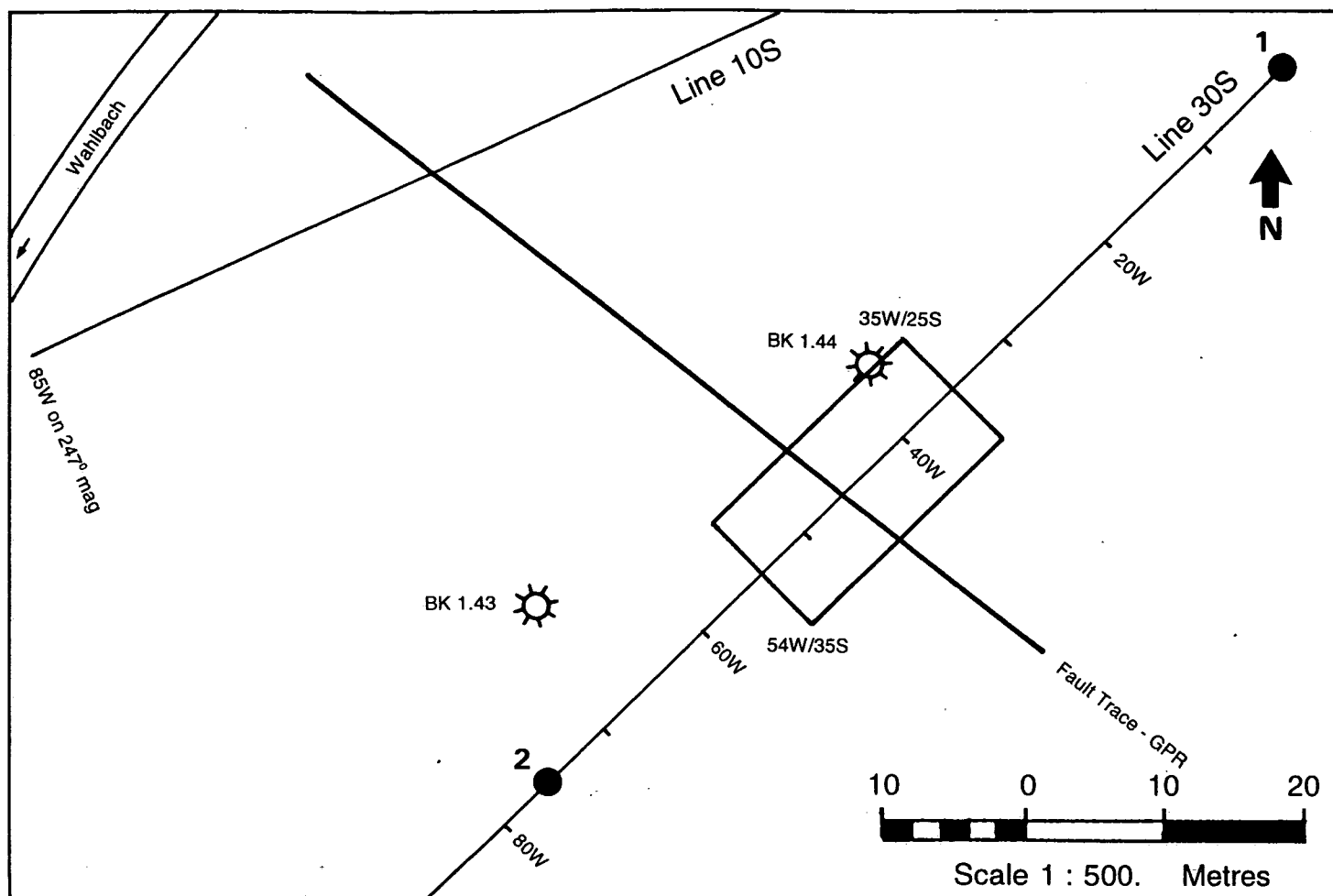


Figure 30 *rsc.* Test Site 1.4. Plan (partial) of site showing location of RESCAN grid.

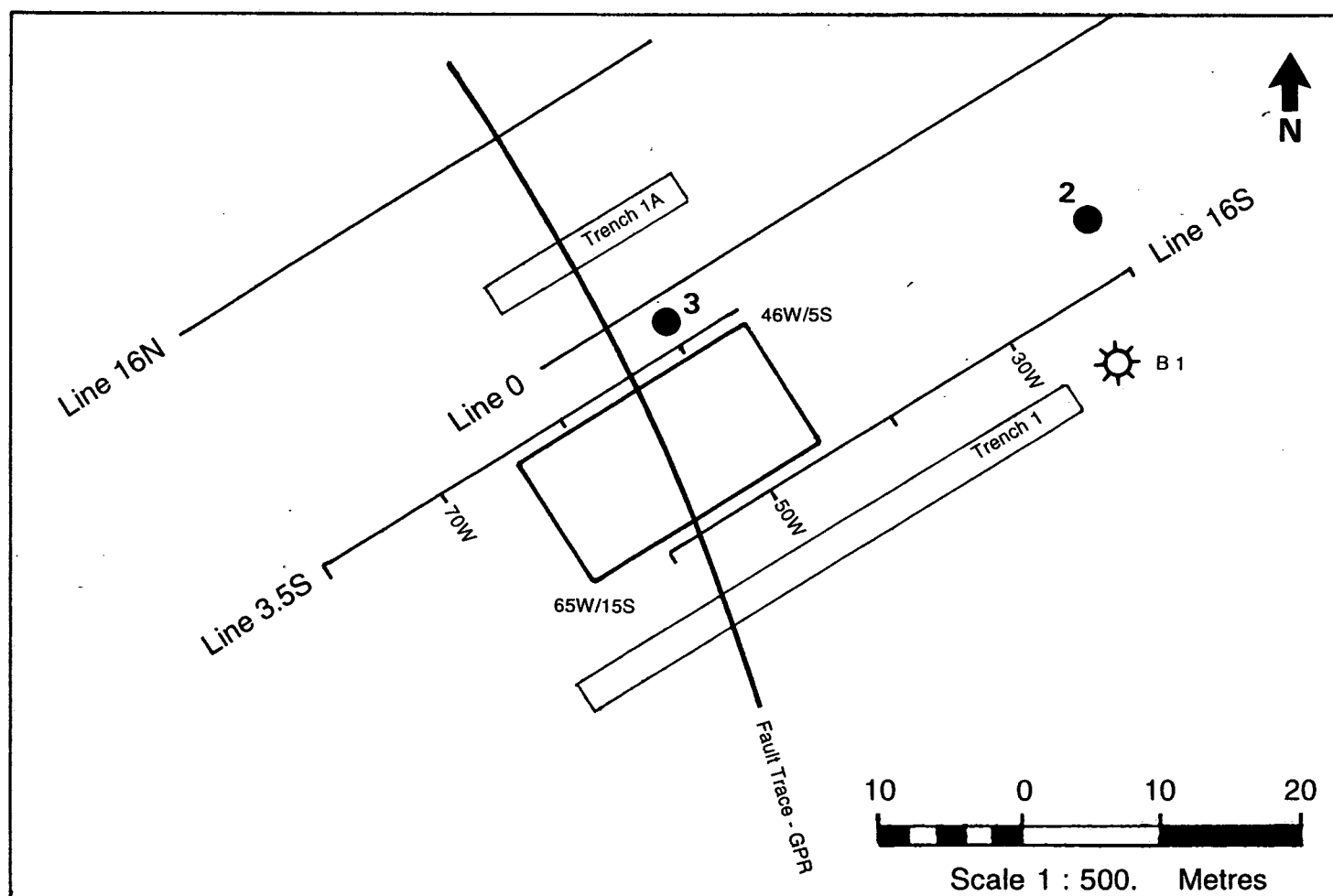


Figure 31 *rsc.* Test Site 2.1. Plan (partial) of site showing location of RESCAN grid.

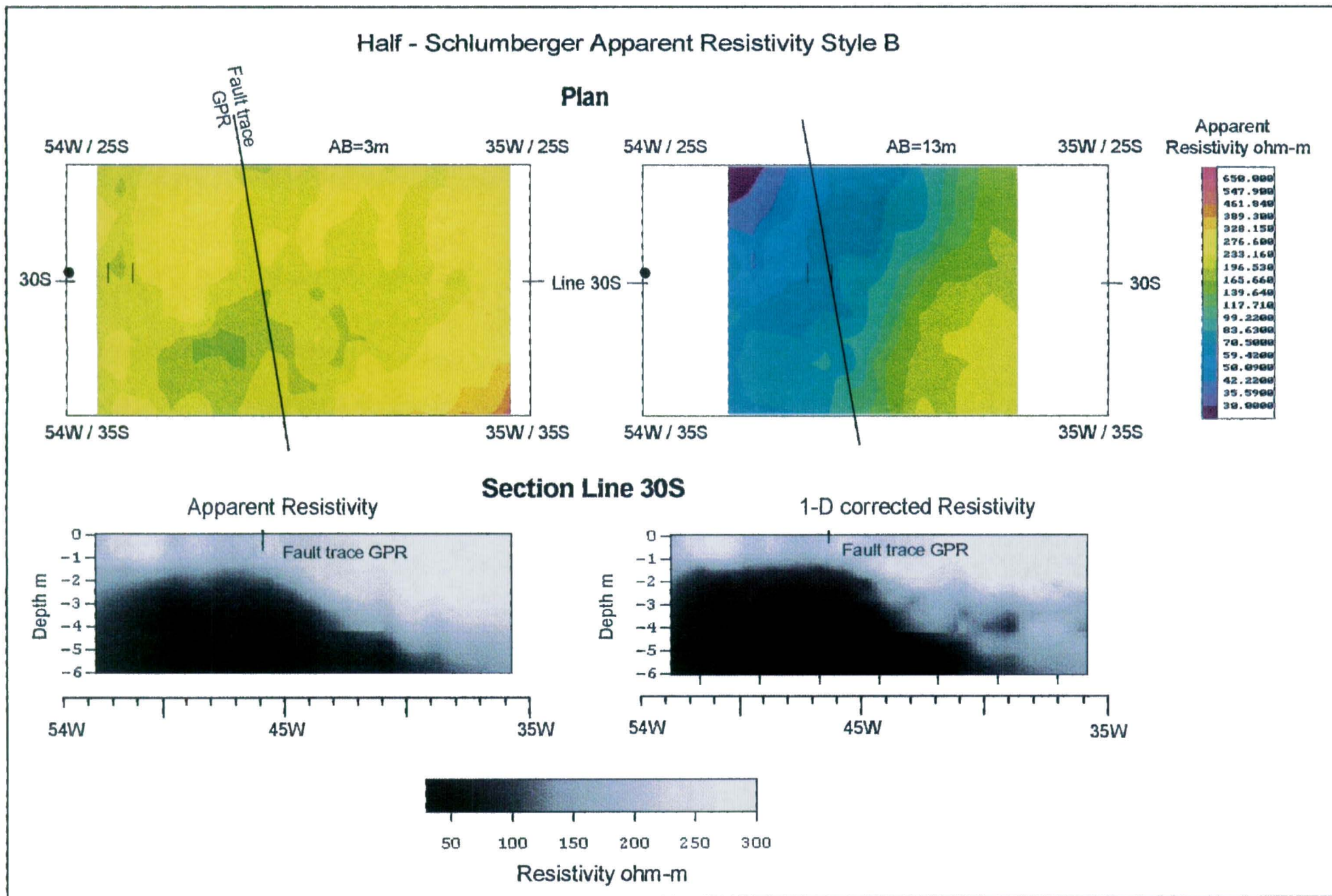


Figure 8 *rsc.* Test Site 1.4. Resistivity imaging using pole-dipole 'half Schlumberger' measurements made under computer control. Pseudo and 1D corrected XZ sections show different responses over a fault identified by GPR.

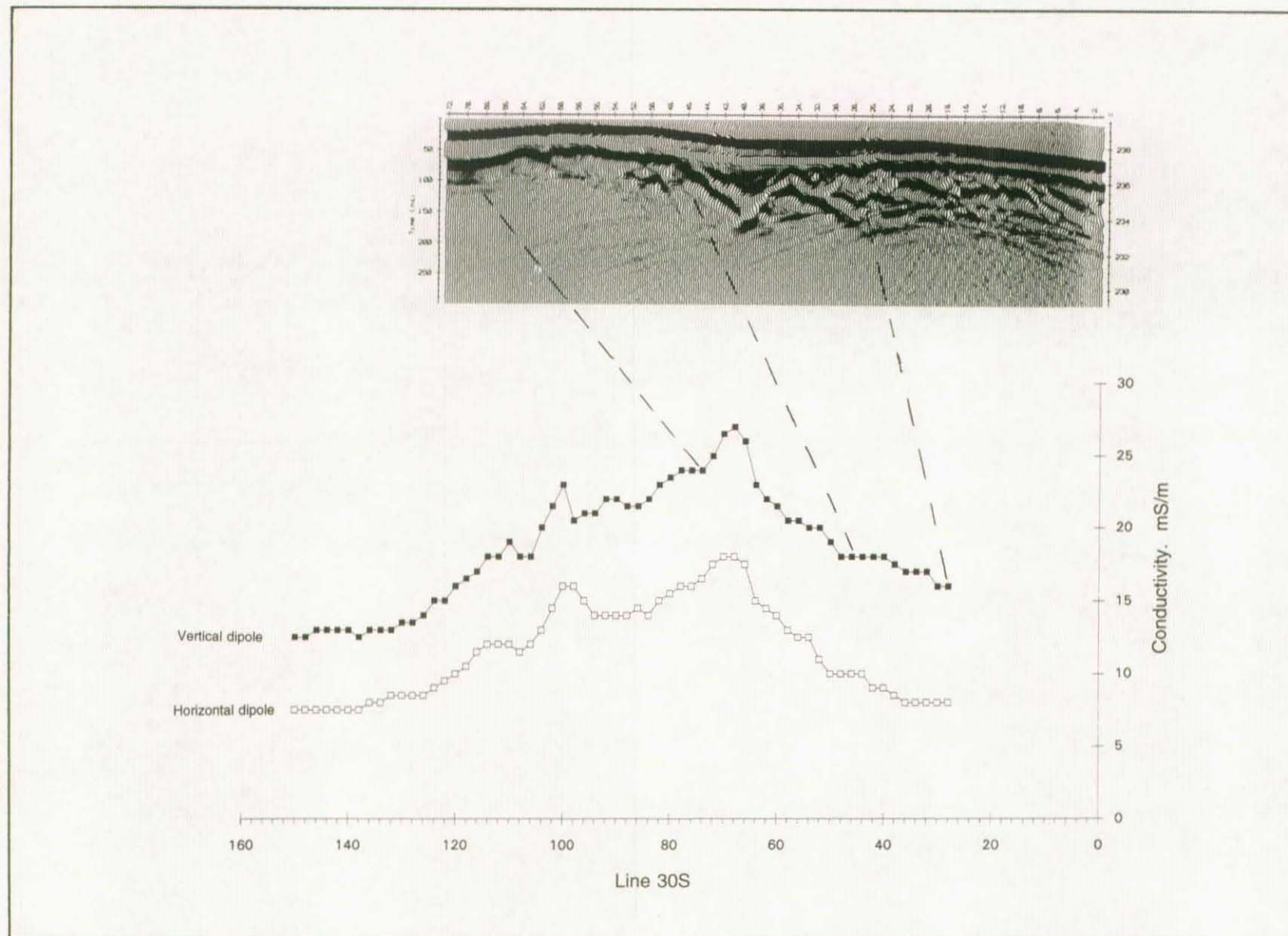
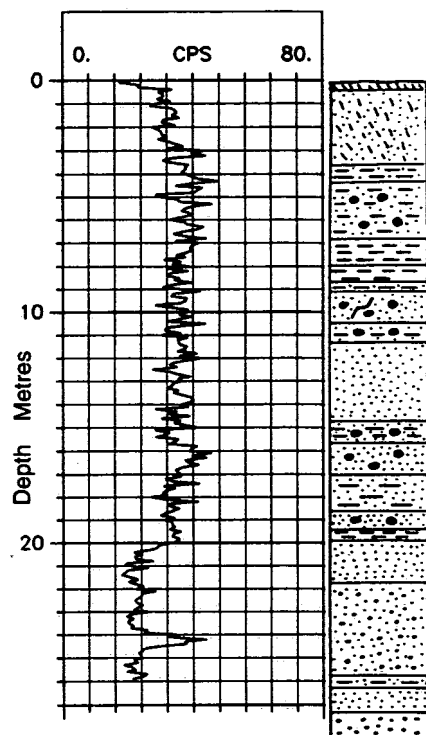
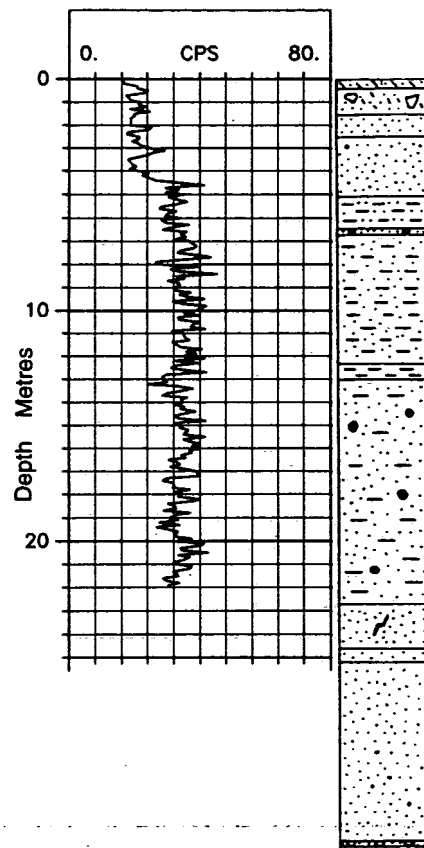


Figure 7 em. Test Site 1.4. Composite horizontal and vertical dipole conductivity and GPR section for line 30S.



Borehole BK 1.43



Borehole BK 1.44

Figure 2 *gam.*

Test Site 1.4. Natural gamma logs for boreholes BK1.43 to BK1.44.

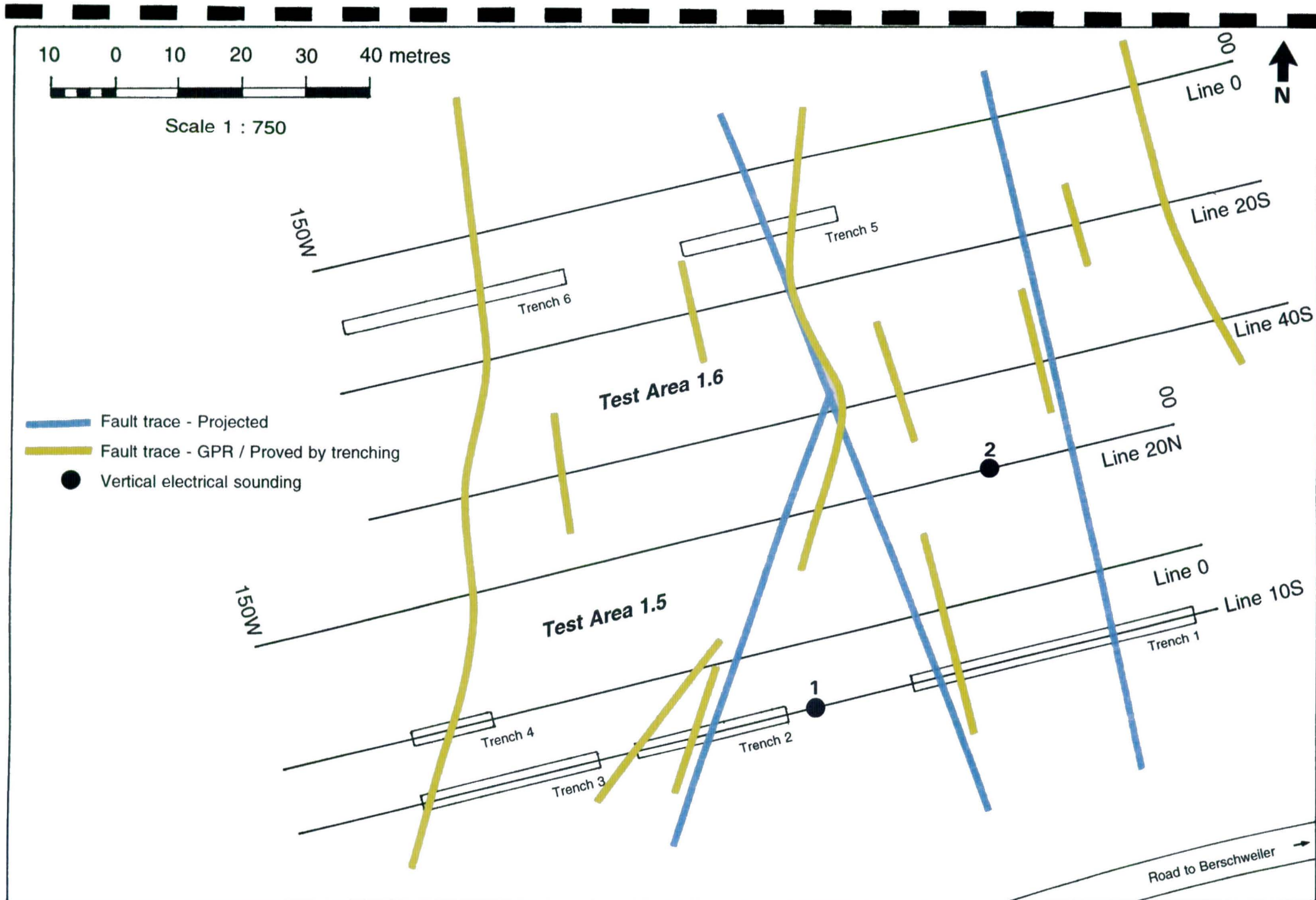
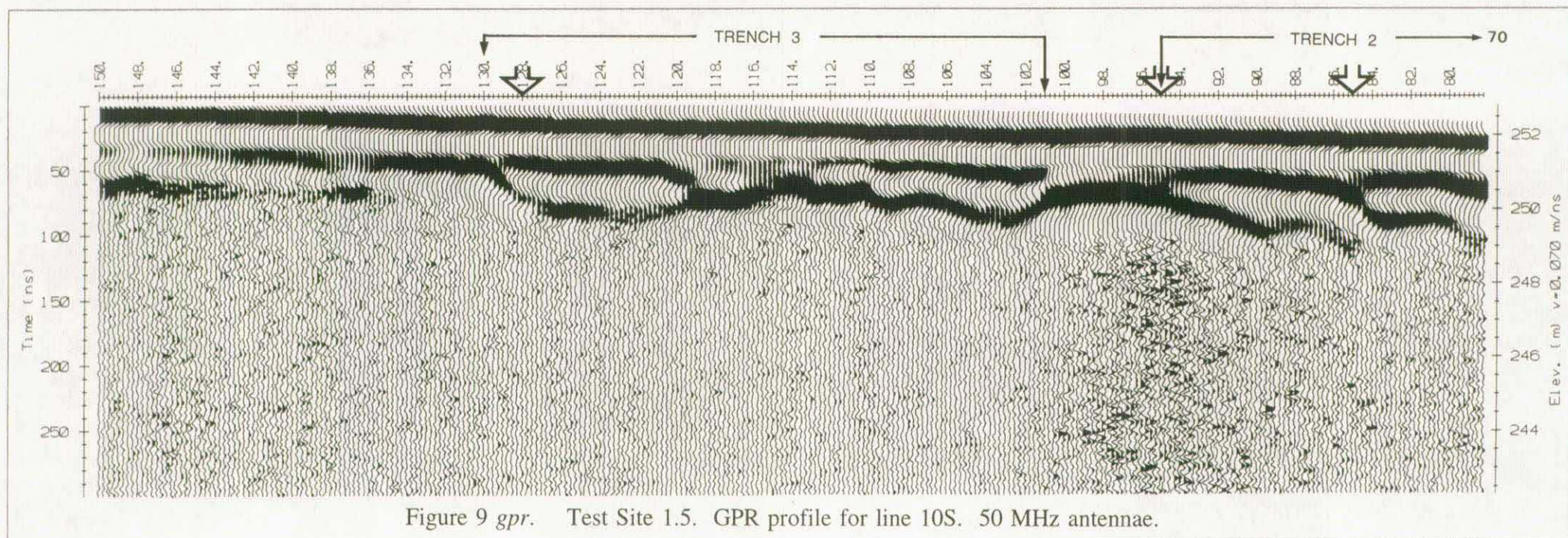
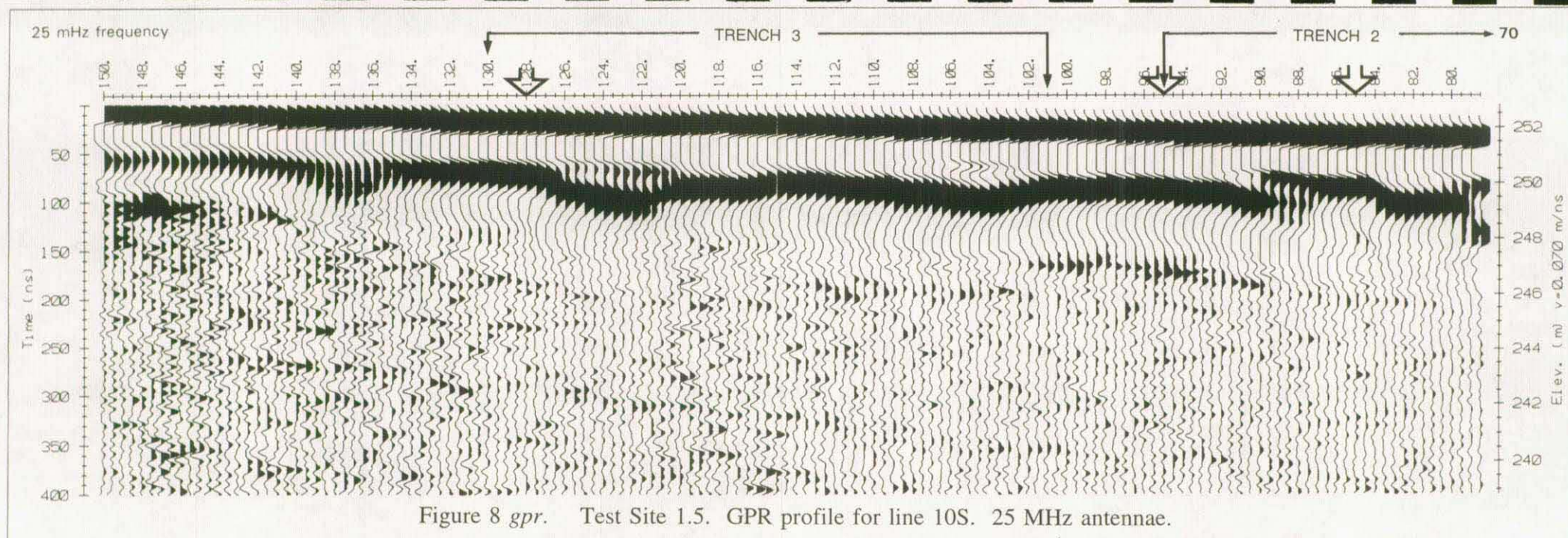
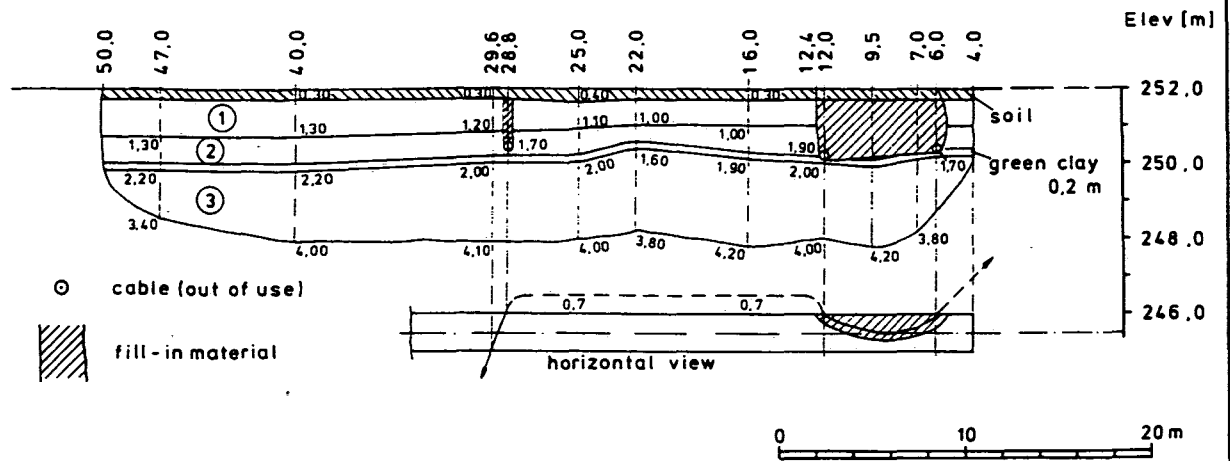


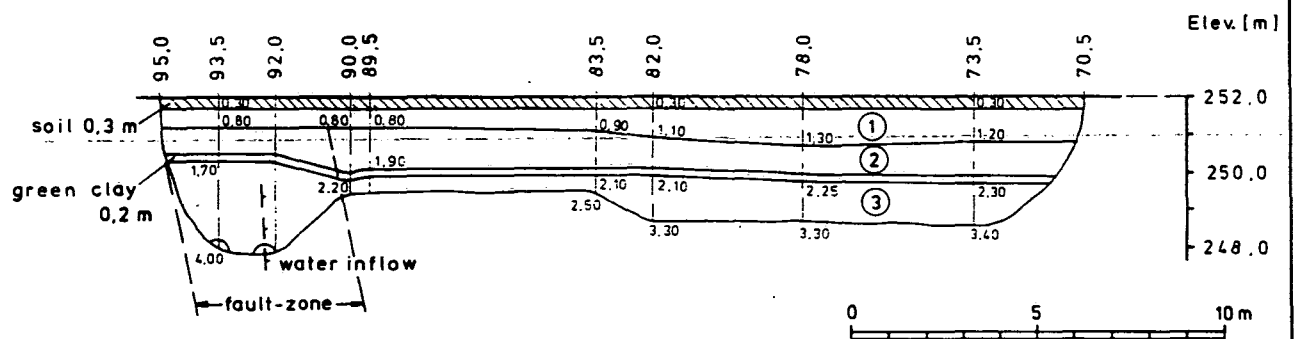
Figure 11. Test Sites 1.5 and 1.6. Geophysical grid, trench locations, and interpretation.



Test Area 1.5, Line 10 S, Trench 1



Test Area 1.5, Line 10 S, Trench 2



Test Area 1.5, Line 10 S, Trench 3

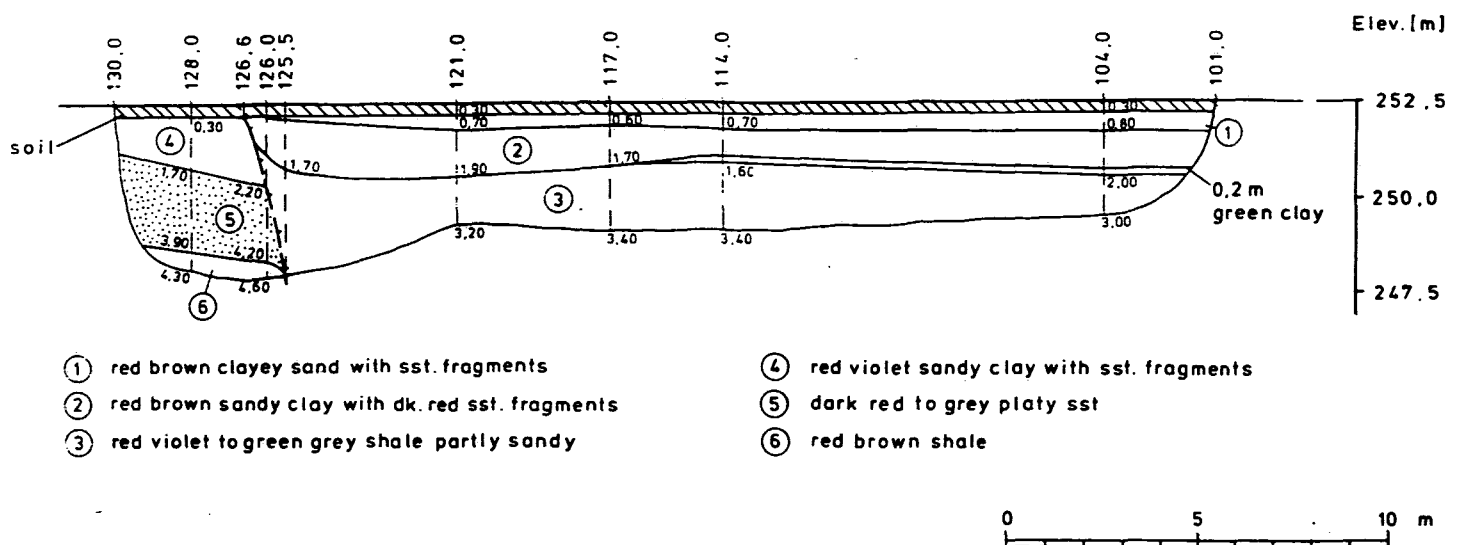


Figure 12. Test Site 1.5. Trenches 1, 2, and 3, line 10S.

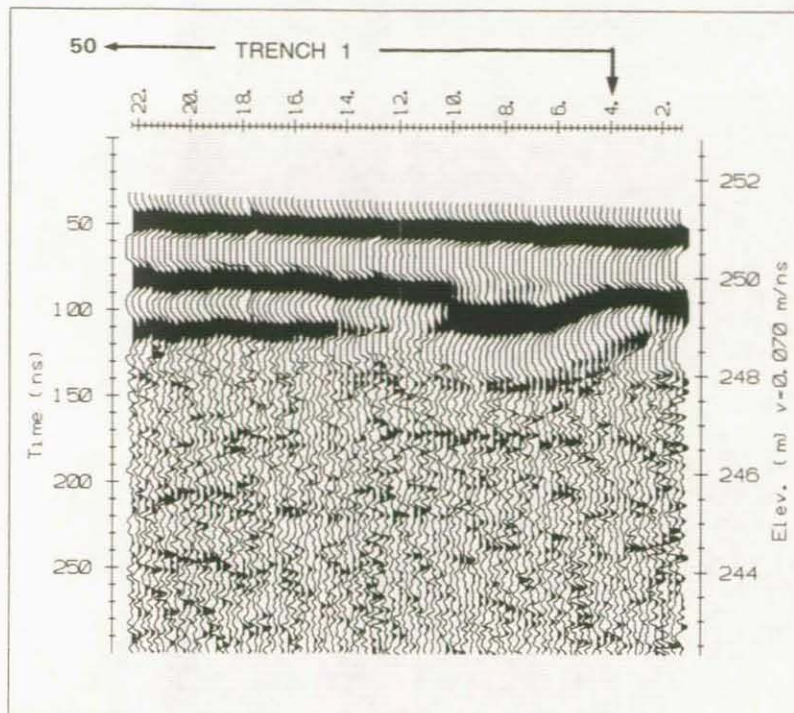
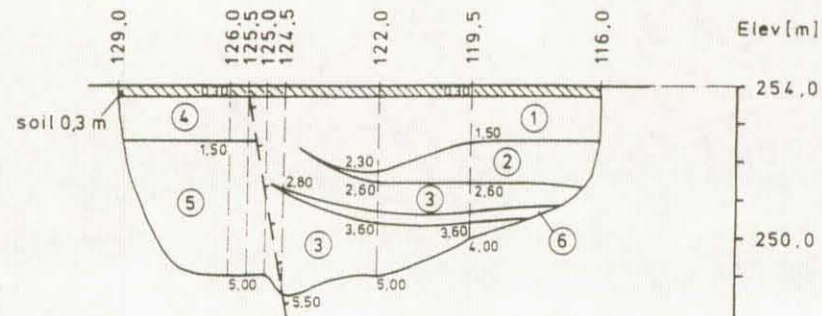


Figure 10 *gpr*. Test Site 1.5. GPR profile for line 10S (eastern end).
50 MHz antennae.

Test Area 1.5, Line 0N, Trench 4



- ① red brown sandy clay with sst. fragments
- ② dark red clay with sst. fragments
- ③ red brown shale

- ④ red brown clayey sand
- ⑤ grey green to brown shale, partly sandy
- ⑥ 0.3m grey shale with 7cm coal seam

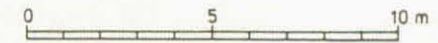


Figure 13. Test Site 1.5. Trench 4, line 0.

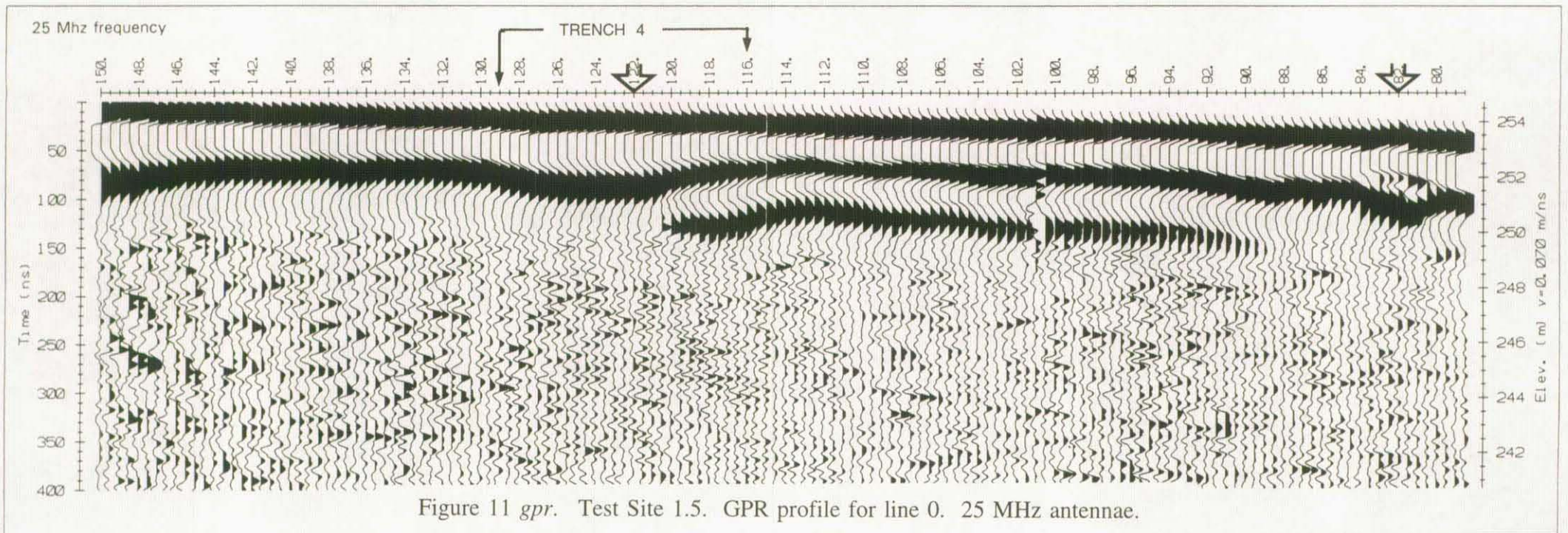


Figure 11 *gpr*. Test Site 1.5. GPR profile for line 0. 25 MHz antennae.

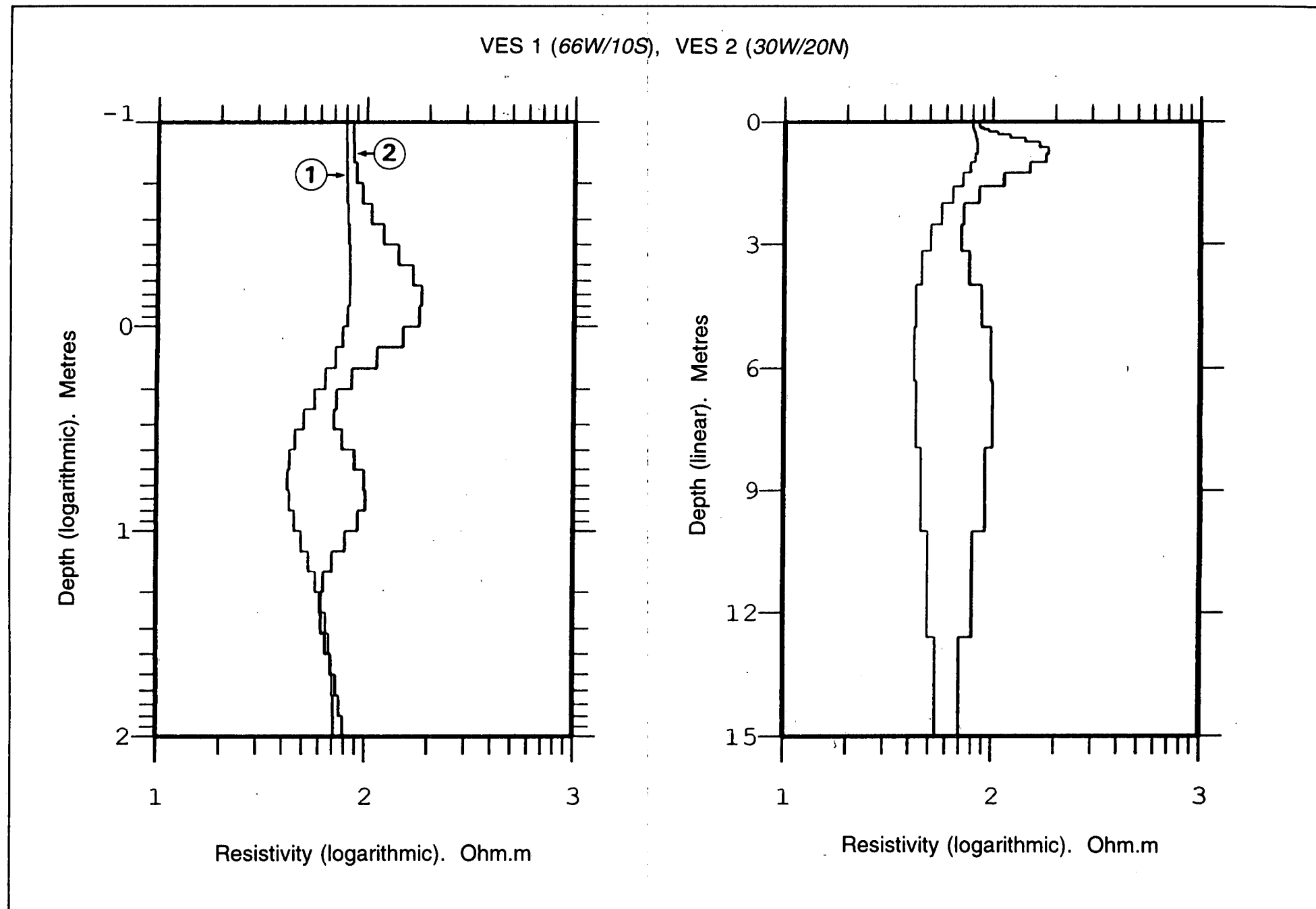


Figure 5 *res.*

Test Site 1.5. Interpretation of VES 1, and 2.

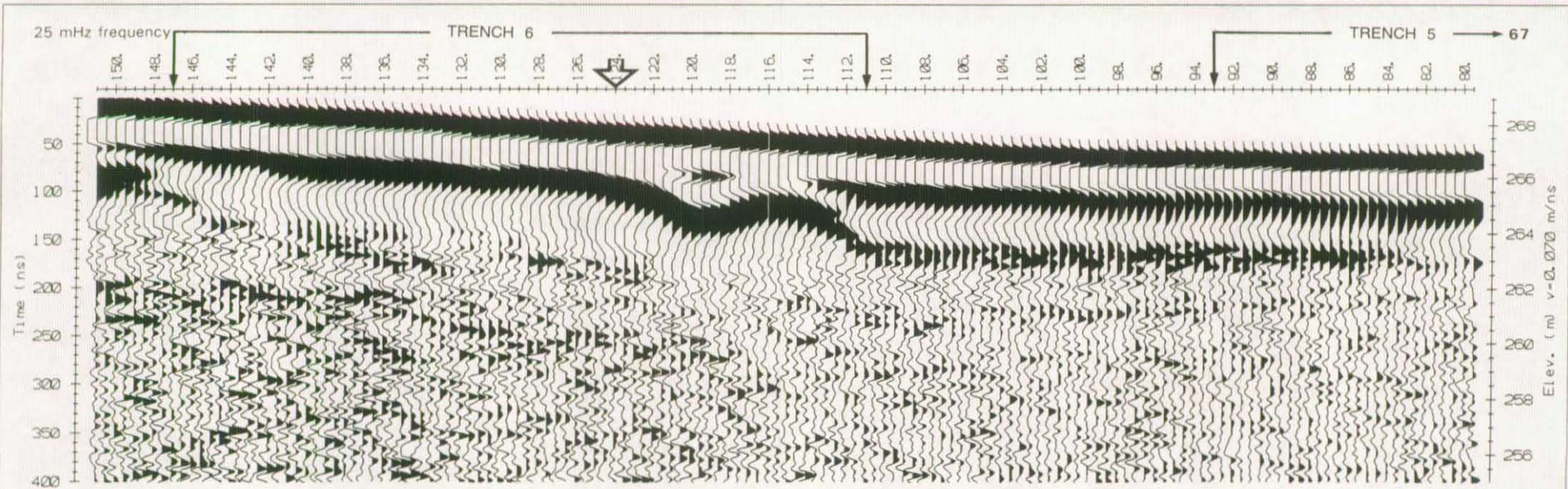


Figure 12 *gpr*. Test Site 1.6. GPR profile for line 0. 25 MHz antennae.

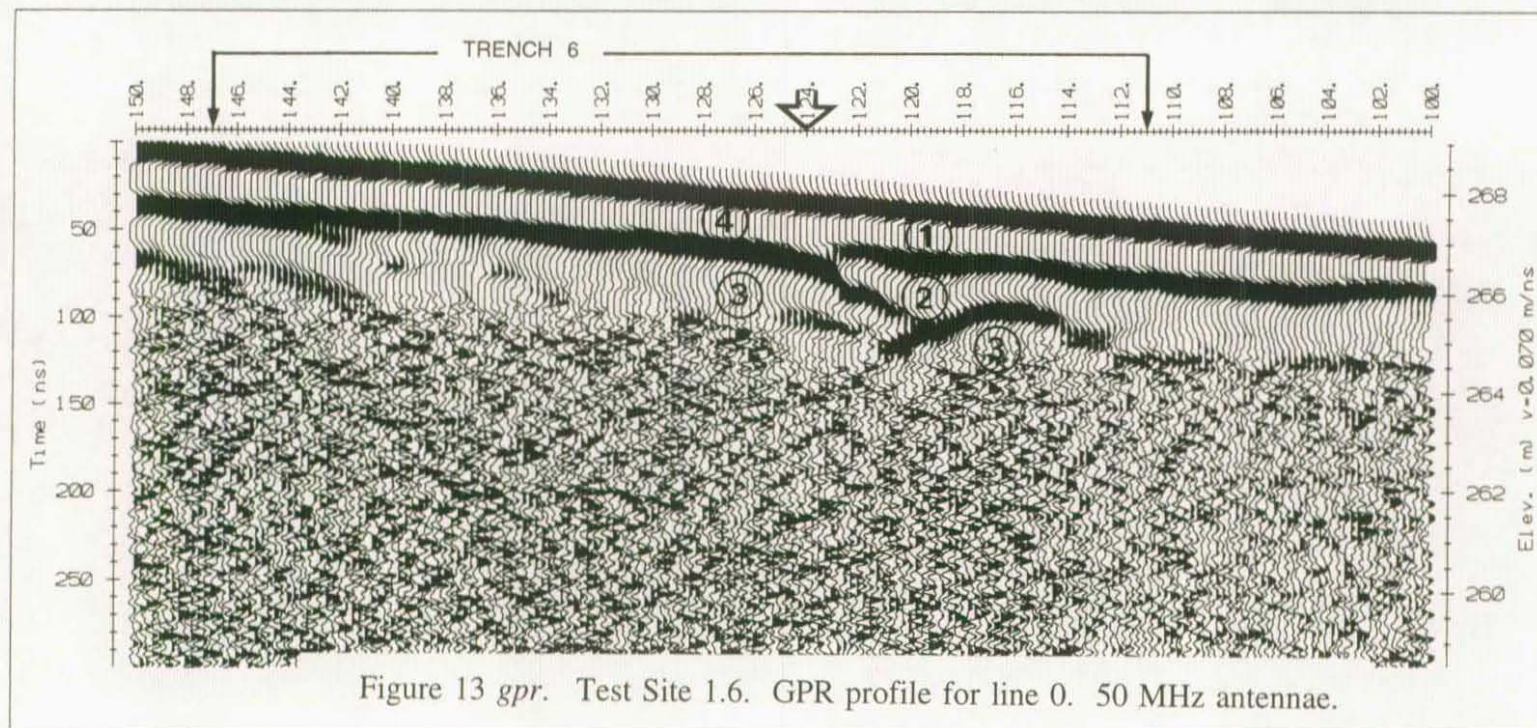
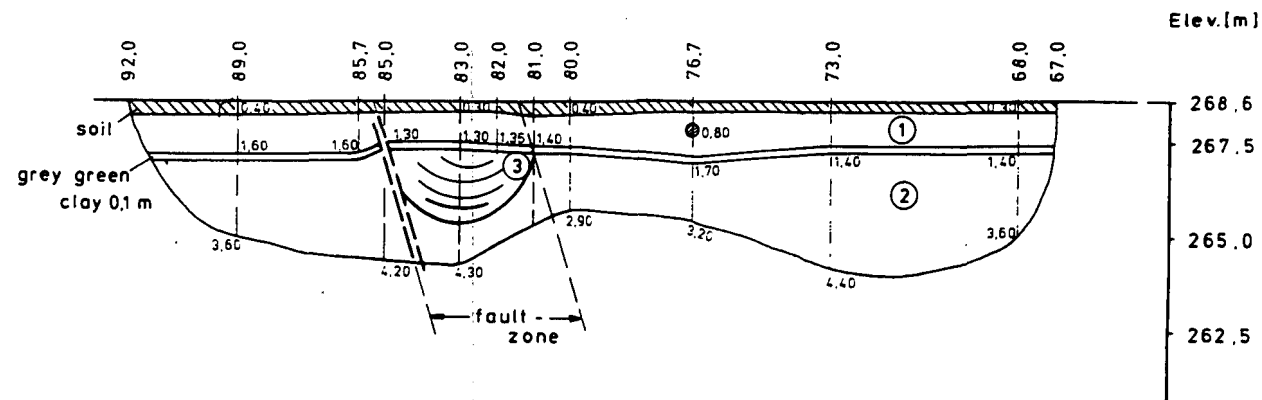


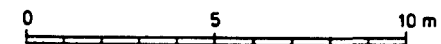
Figure 13 *gpr*. Test Site 1.6. GPR profile for line 0. 50 MHz antennae.

Test Area 1.6, Line 10 S, Trench 5

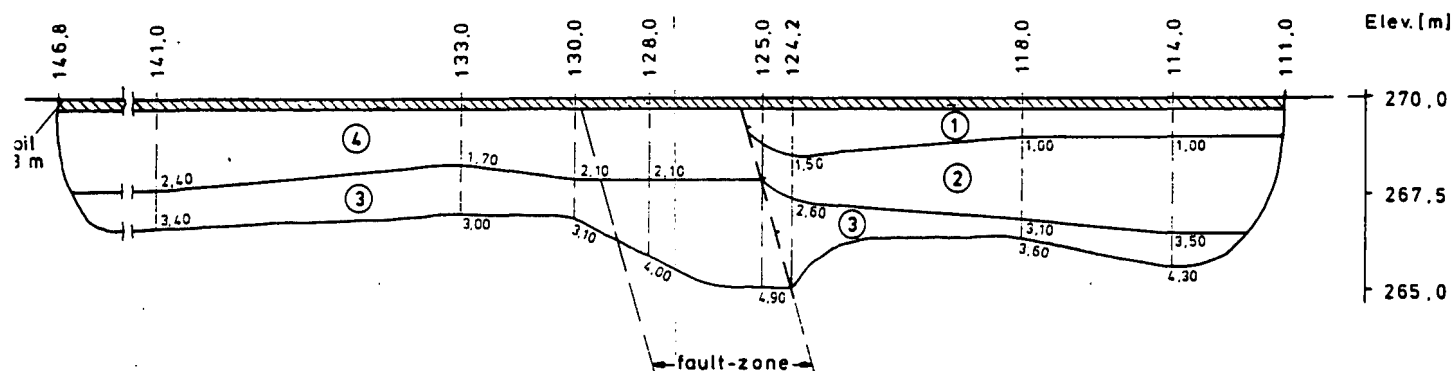


- ① red brown shale partly crumbly
- ② red violet shale partly sandy

- ③ slickenside dipping to the south
- sewage pipe (concrete 20 cm Ø)



Test Area 1.6, Line 10 S, Trench 6



- ① light brown sandy clay with sst. fragments
- ② grey green to red violet shale partly sandy and compact partly brittle

- ③ red violet shale
- ④ red brown clayey sand with sst. fragments

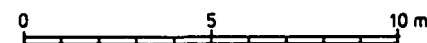


Figure 14. Test Site 1.6. Trenches 5 and 6, line 10S.

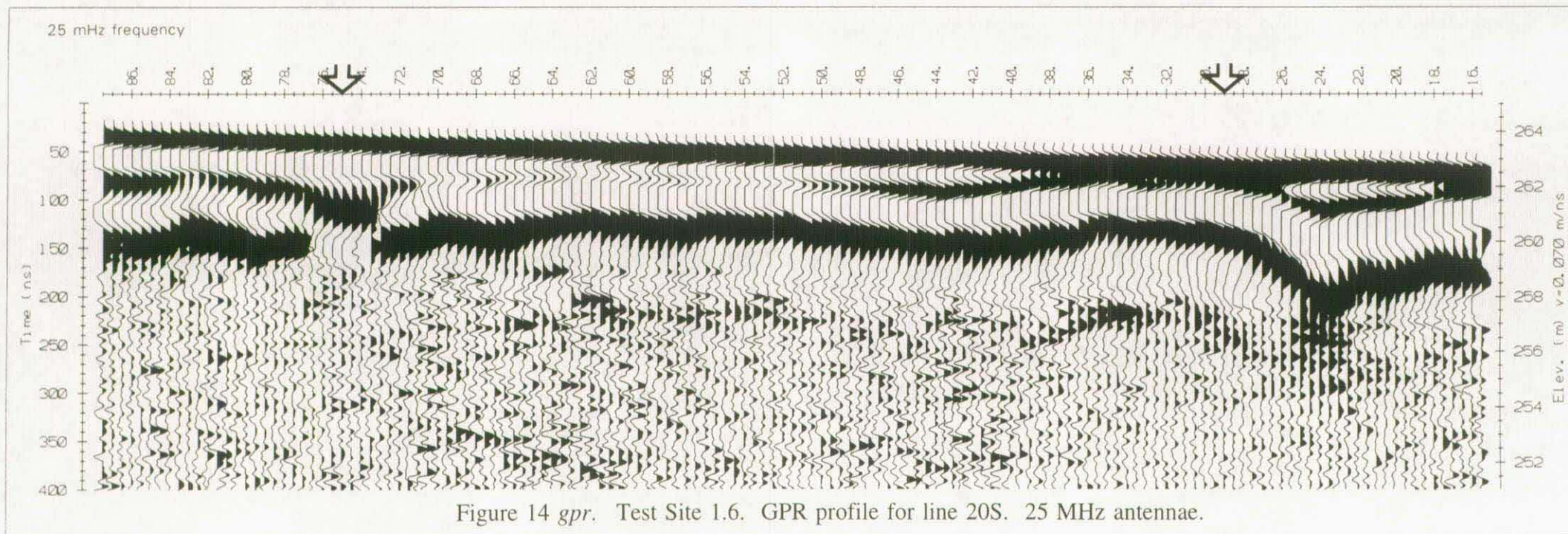
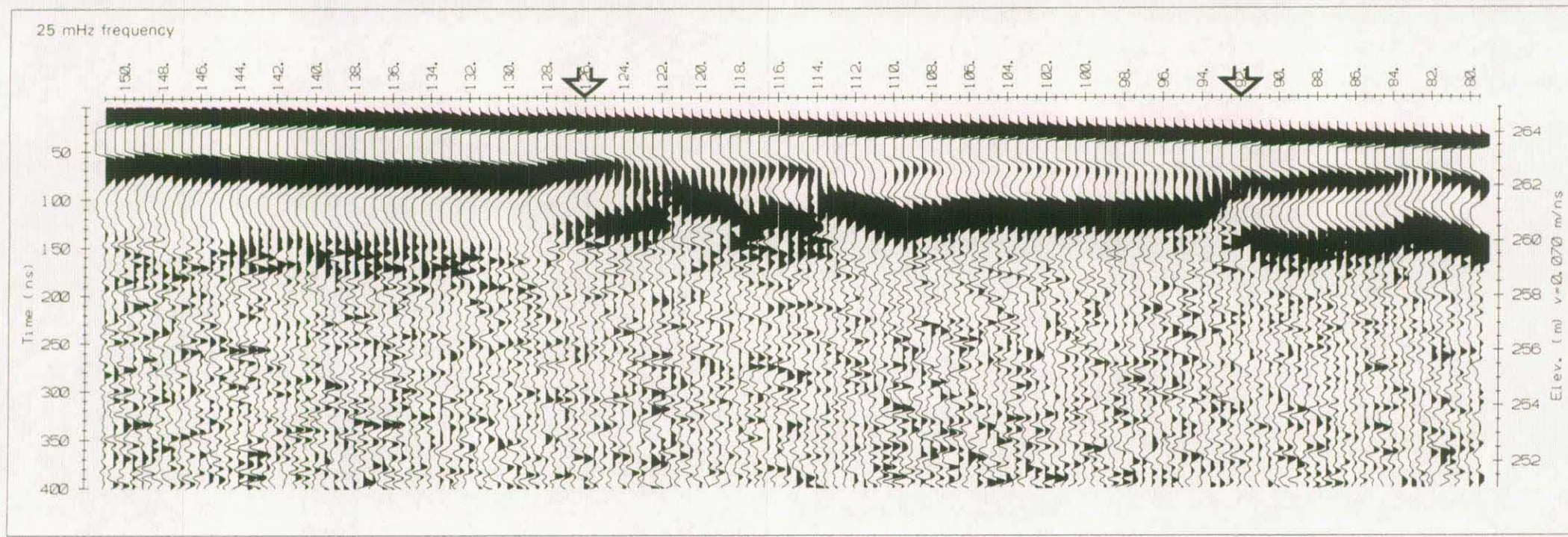
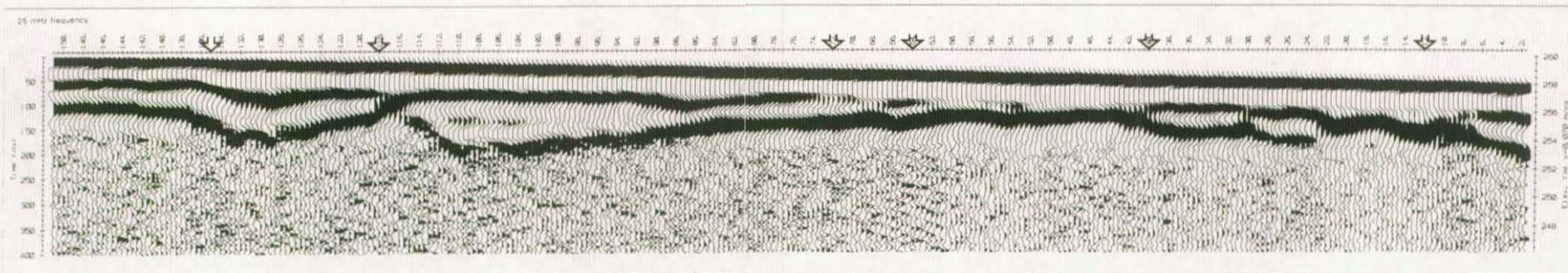
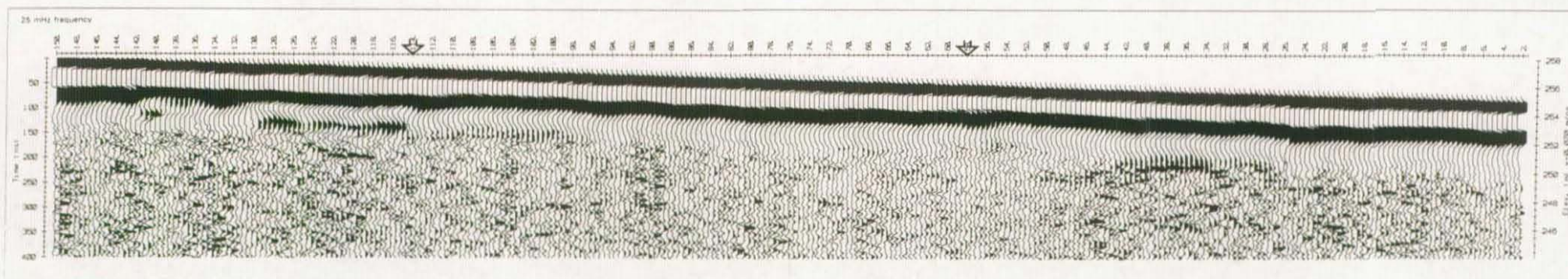


Figure 14 *gpr*. Test Site 1.6. GPR profile for line 20S. 25 MHz antennae.

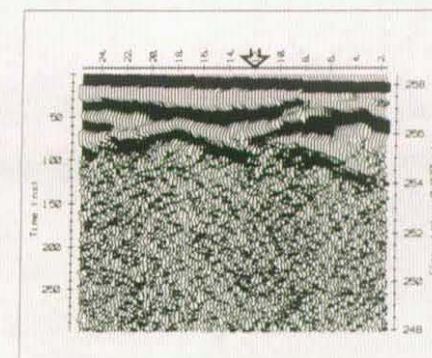
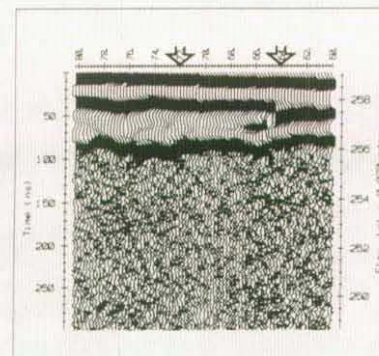
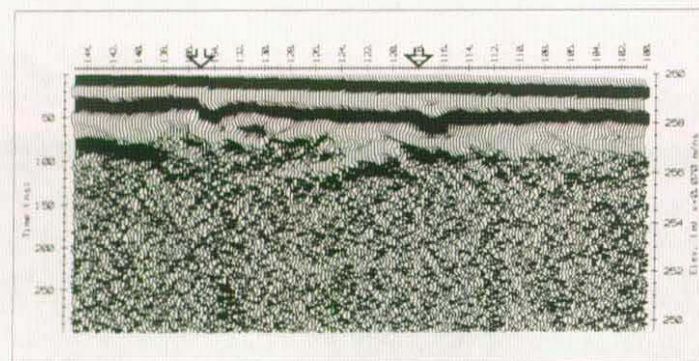


Line 40S (Test Site 1.6)

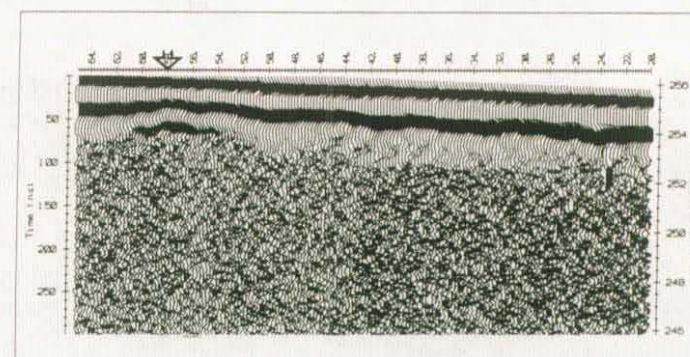
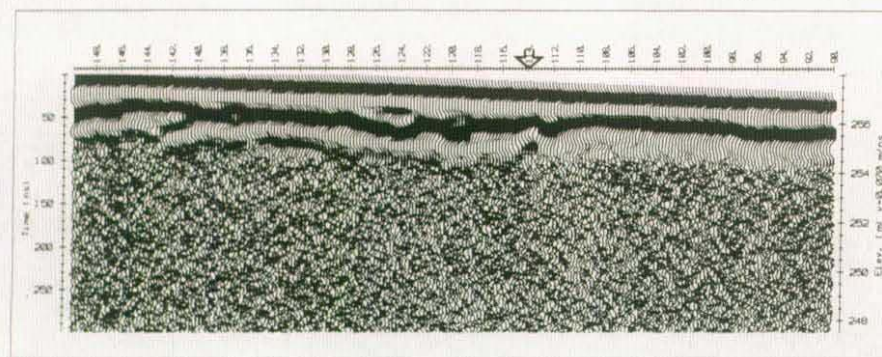


Line 20N (Test Site 1.5)

Figure 15 *gpr*. Test Site 1.6. GPR profile for line 40S and line 20N (Test Site 1.5). 25 MHZ antennae.



Line 40S (Test Site 1.6)



Line 20N (Test Site 1.5)

Figure 16 *gpr*. Test Site 1.6. GPR profile for line 40S and line 20N (Test Site 1.5). 50 MHz antennae.



Figure 15. Test Site 2.1. Geophysical grid, trench and borehole locations, and interpretation. May 1992 survey.

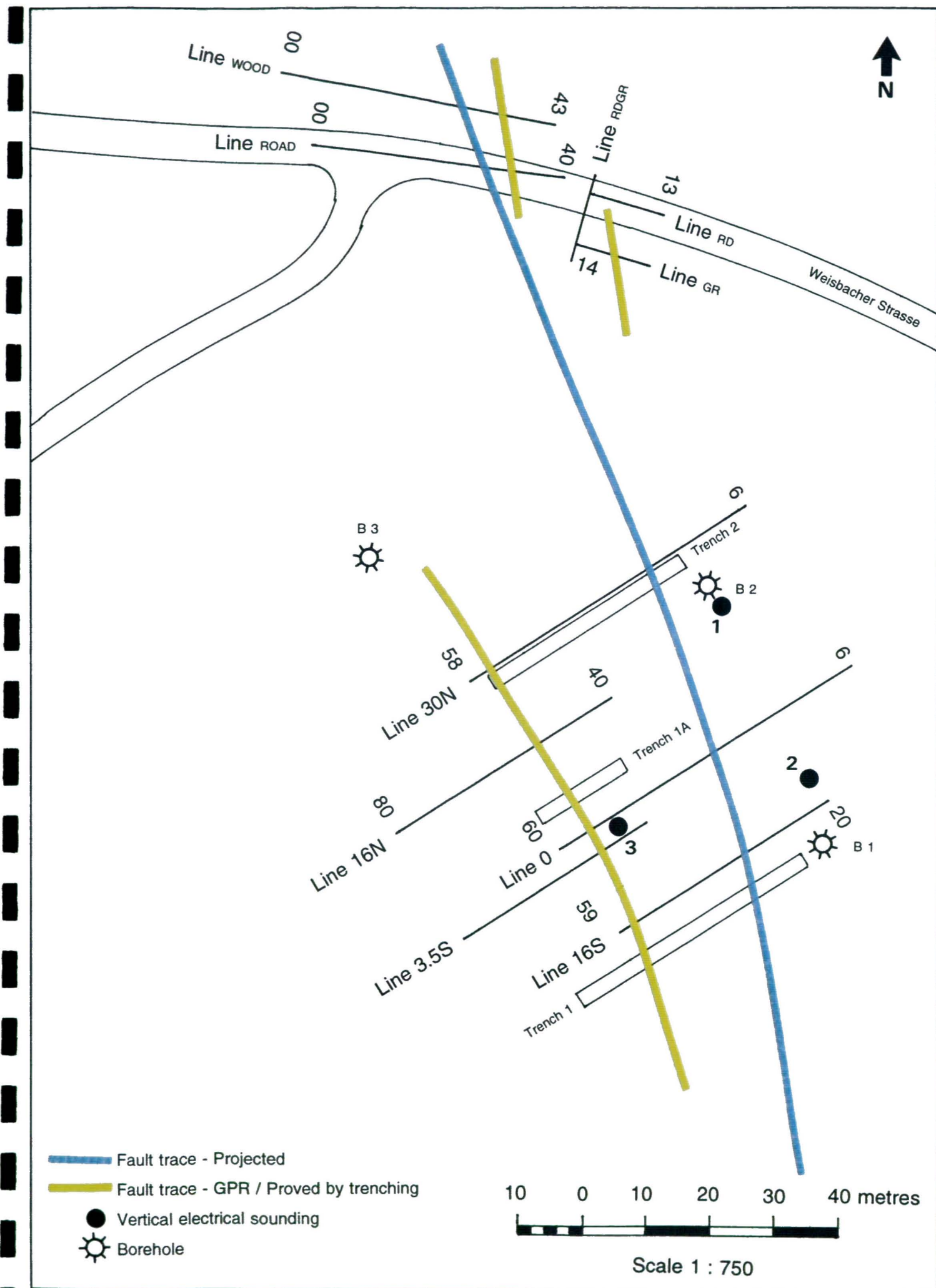


Figure 16. Test Site 2.1. Geophysical grid, trench and borehole locations, and interpretation. December 1992 survey.

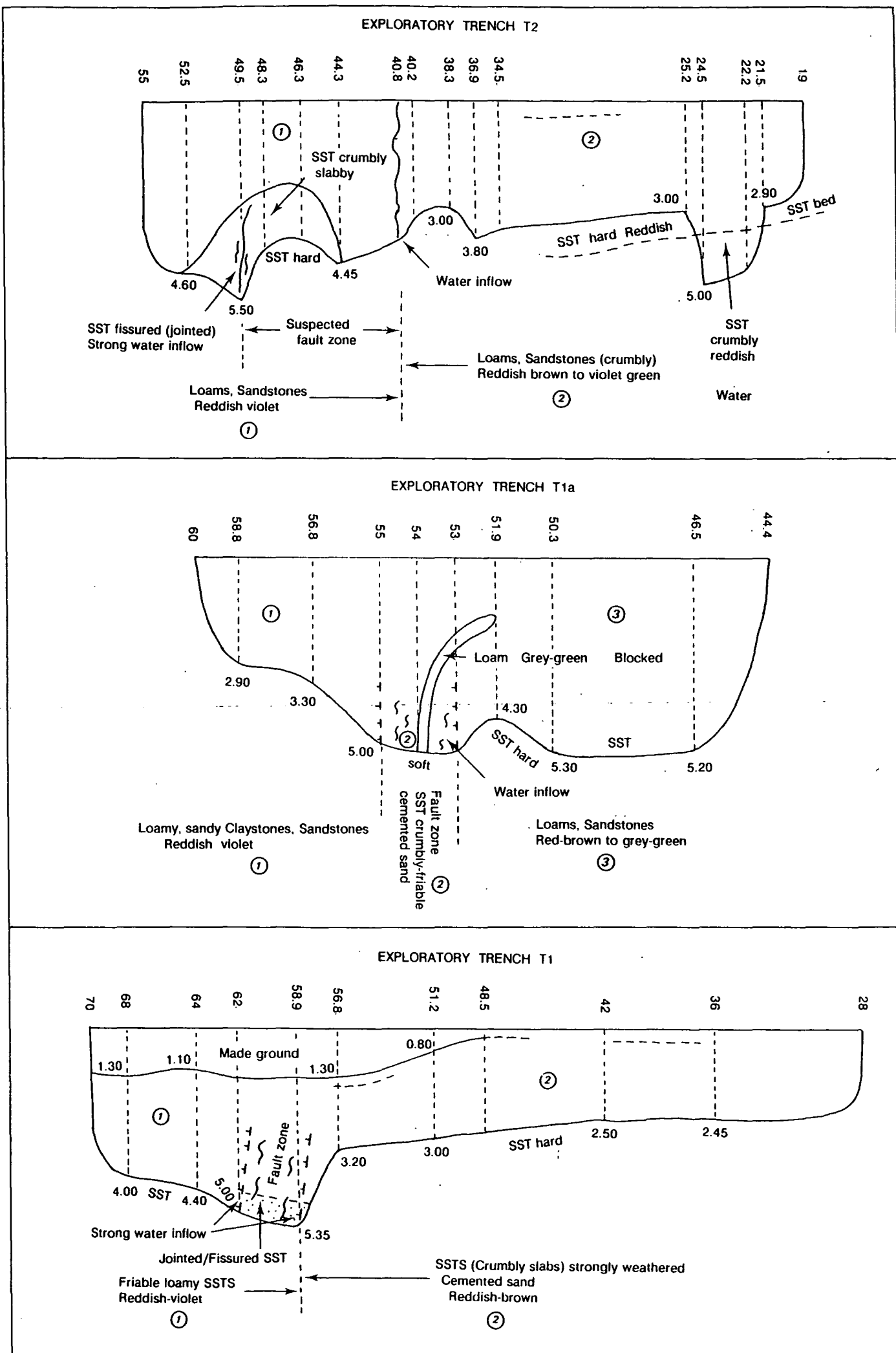
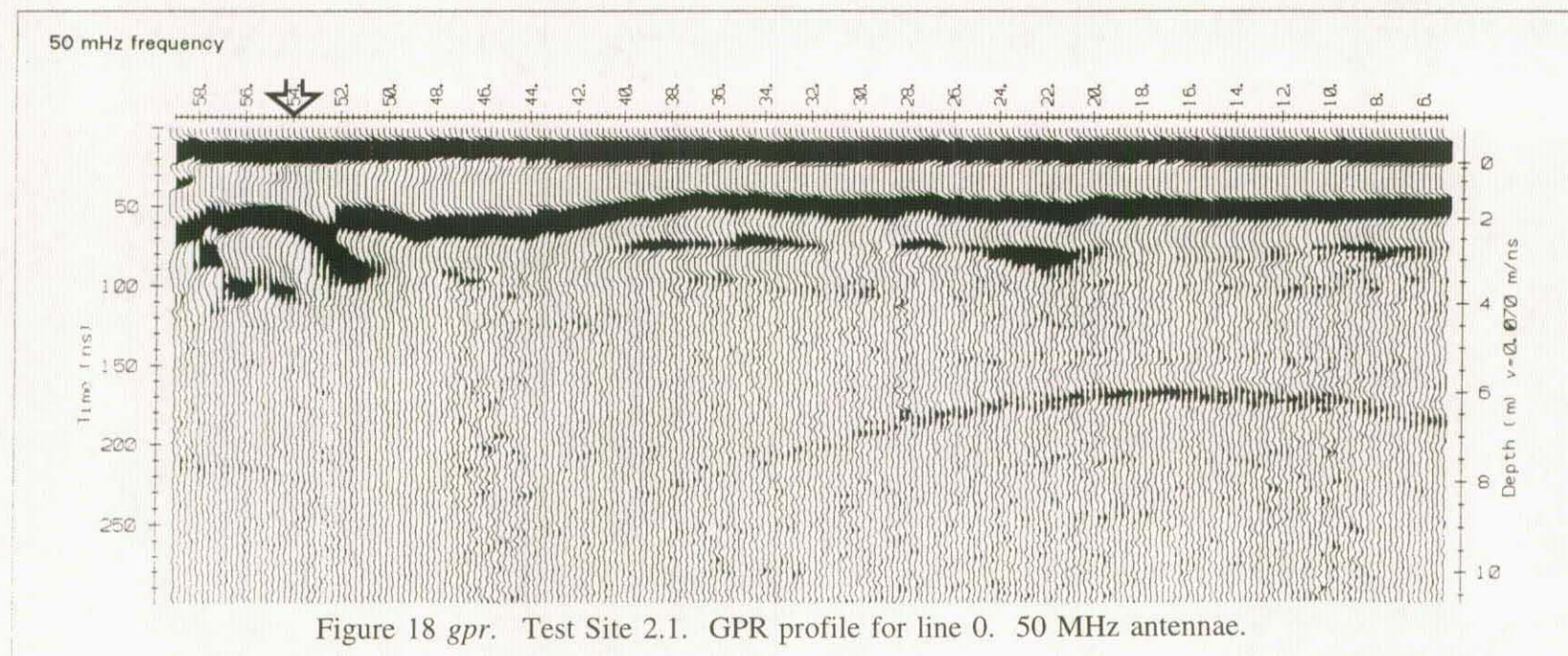
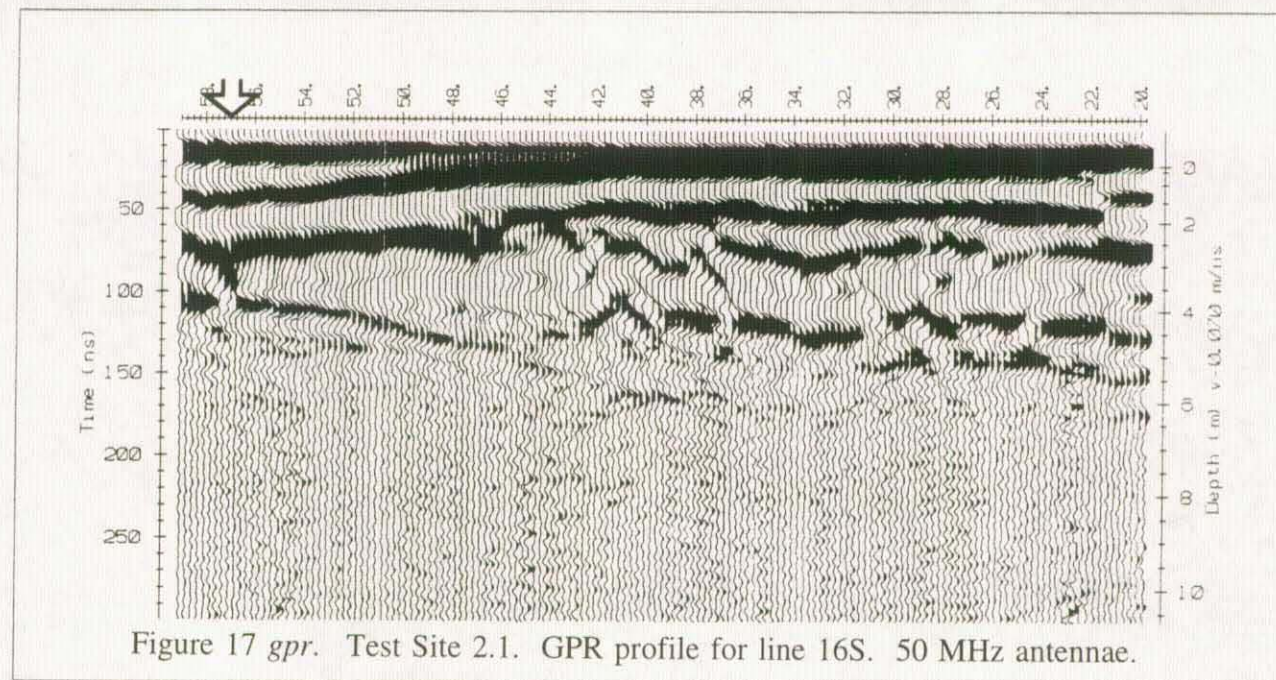


Figure 17. Test Site 2.1. Exploratory trenches T1, T1a, and T2.



50 MHz frequency

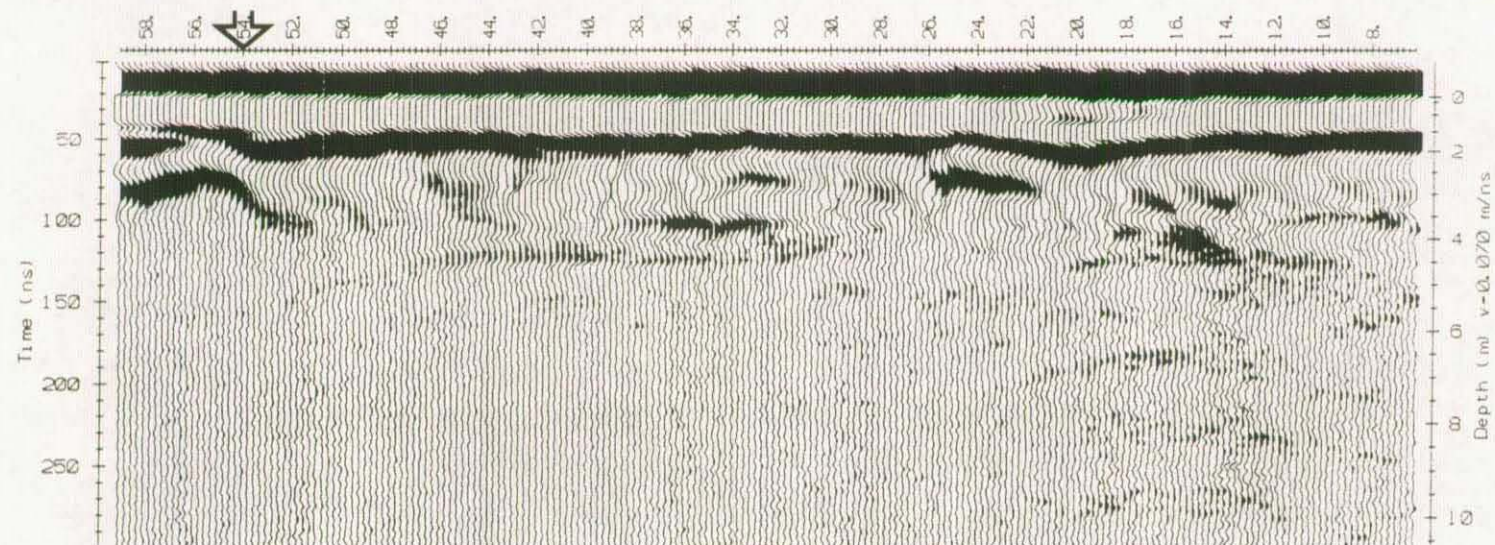


Figure 19 *gpr*. Test Site 2.1. GPR profile for line 30N. 50 MHz antennae.

50 MHz frequency

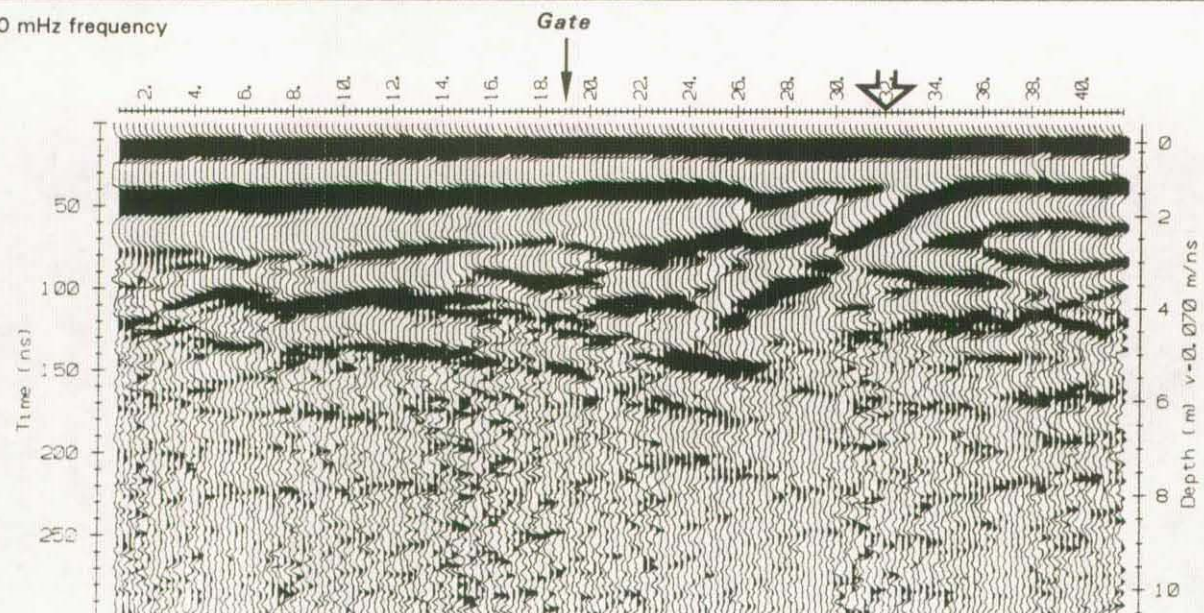
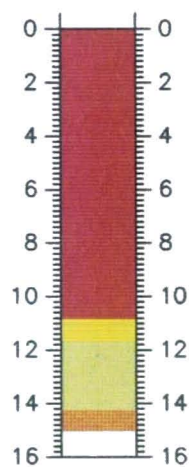
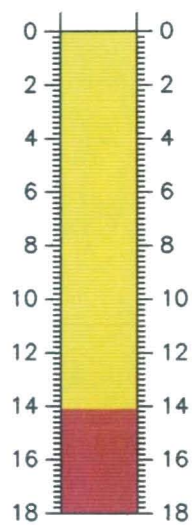


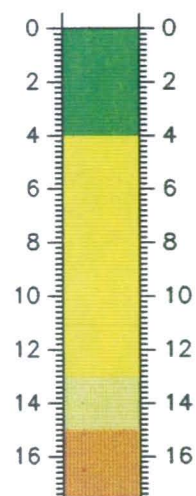
Figure 20 *gpr*. Test Site 2.1. GPR profile for line ROAD. 50 MHz antennae.



B 1



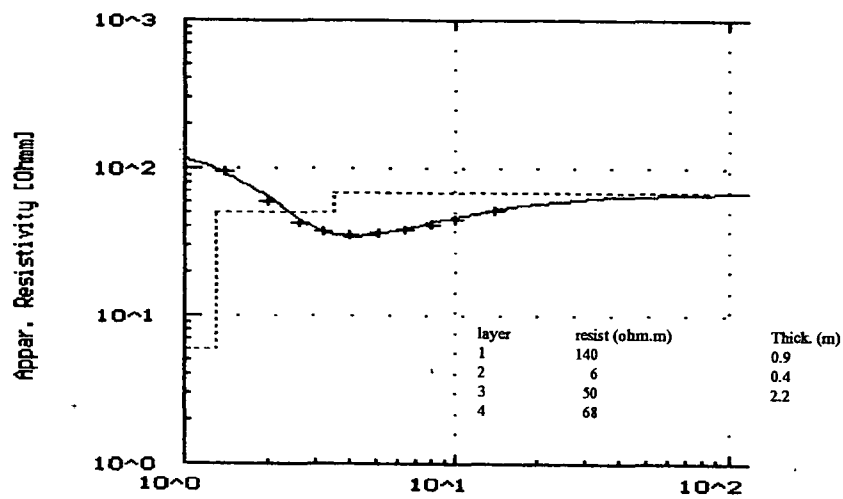
B 2



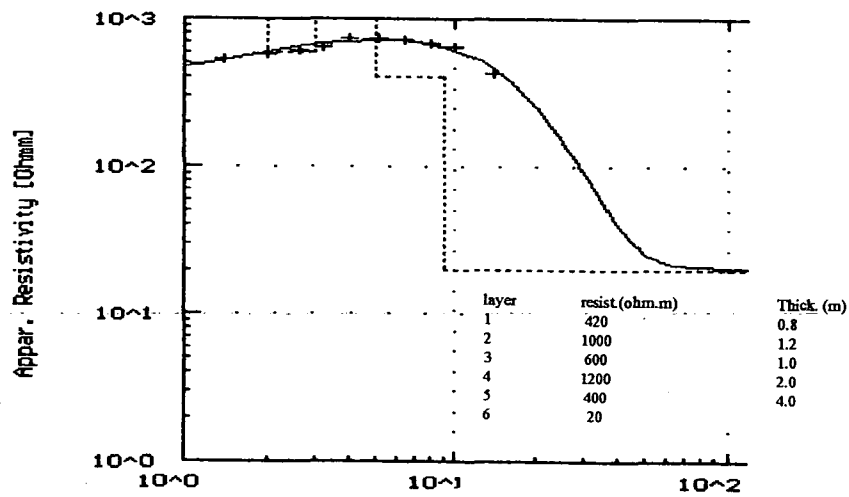
B 3

Figure 18. Test Site 2.1. Geological section: boreholes B1, B2, B3.

1 VES at Test Area 2.1 20W 20N



2 VES at Test Area 2.1 23W 11S



3 VES at Test Area 2.1 52W 2S

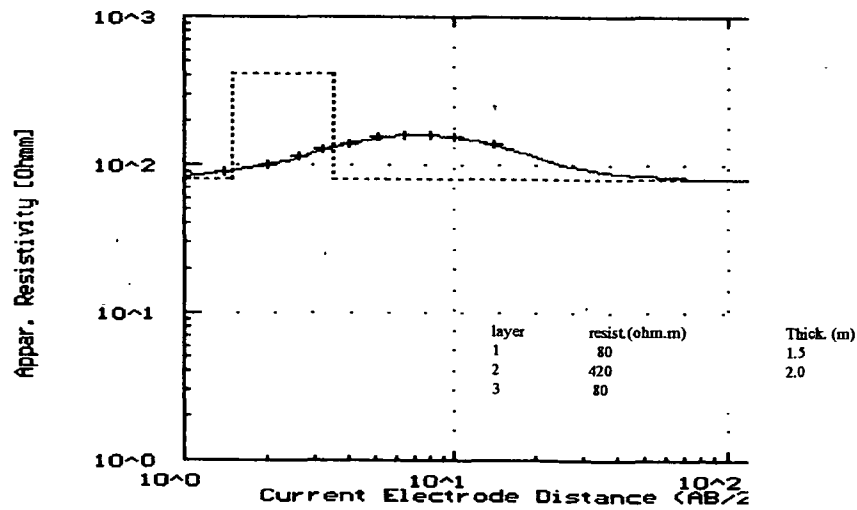


Figure 6 res.

Test Site 2.1. Interpretation of VES 1, 2, and 3.

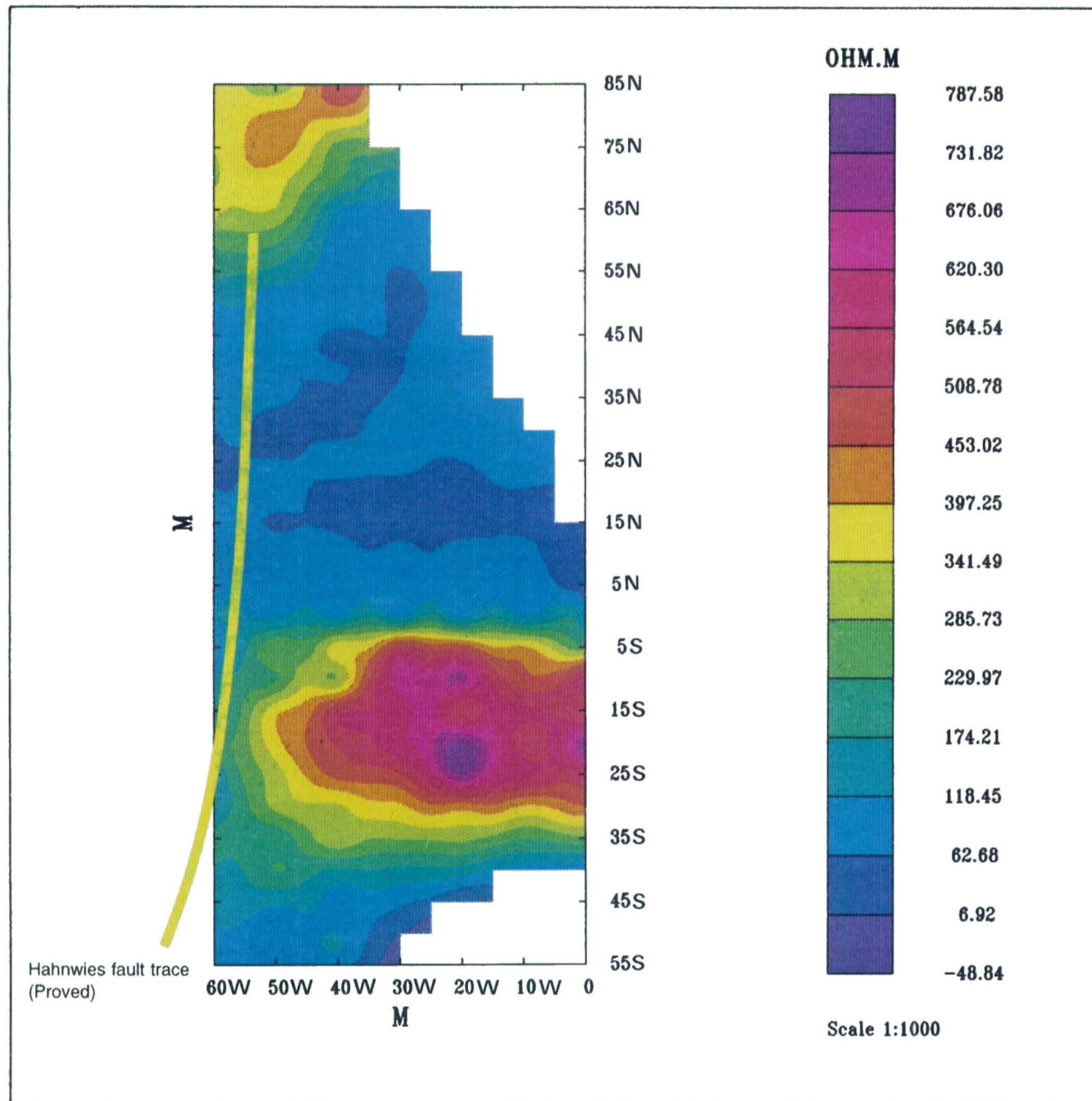


Figure 7 res.

Test Site 2.1. Schlumberger array resistivity contours.

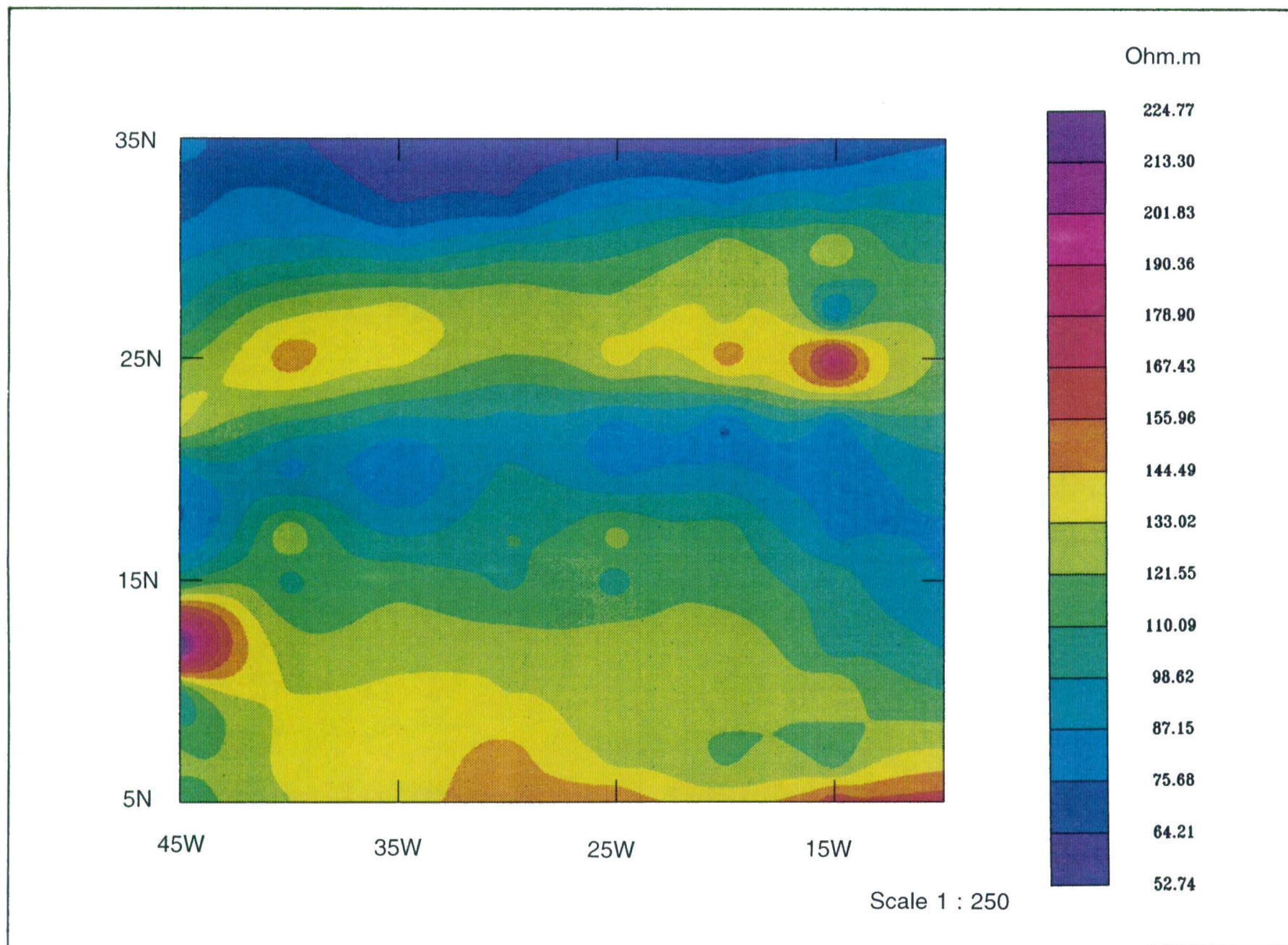


Figure 8 *res.*

Test Site 2.1. Gradient array resistivity contours.

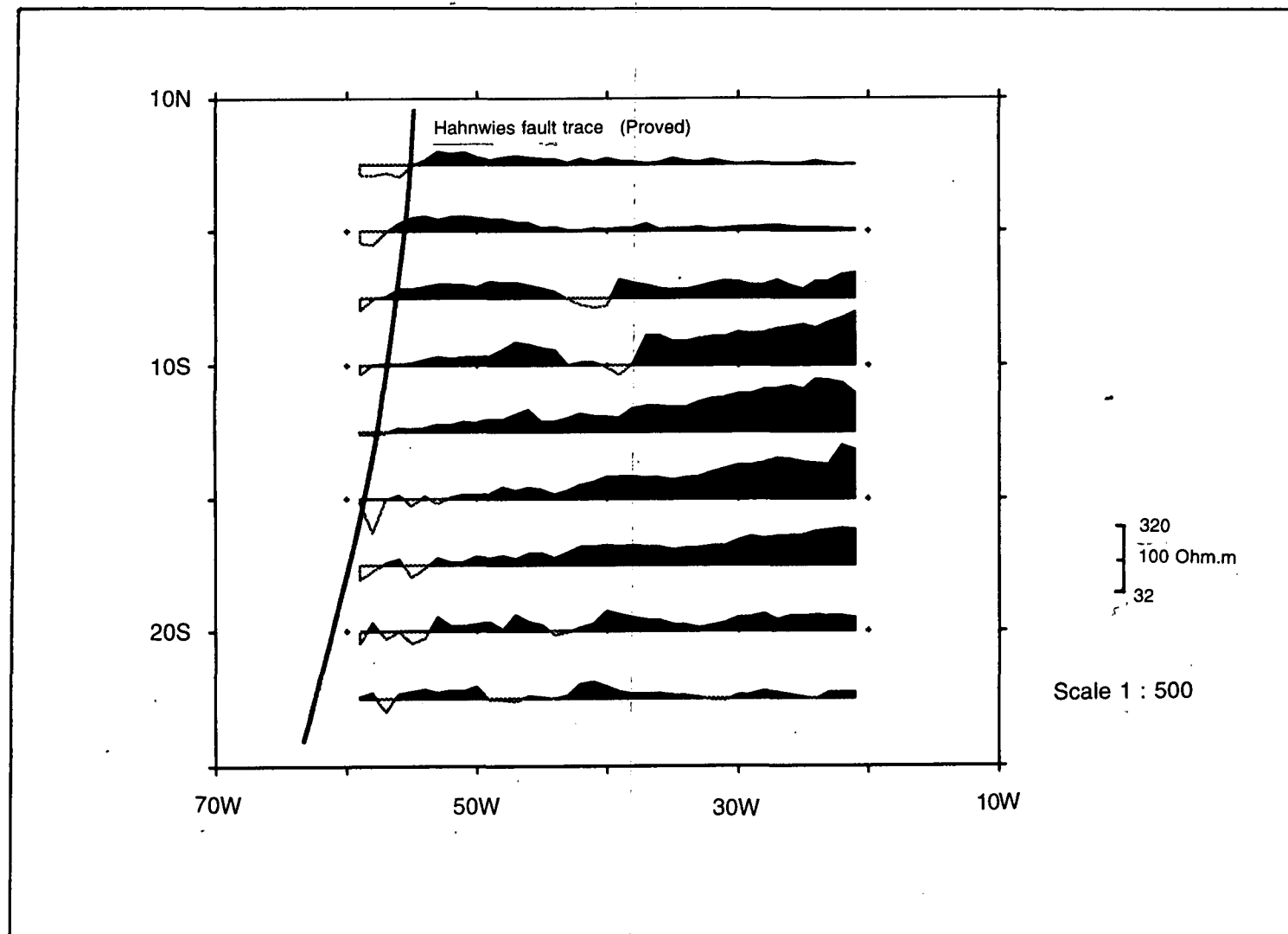


Figure 9 res.

Test Site 2.1. Gradient array resistivity profiles (logarithmic scale).

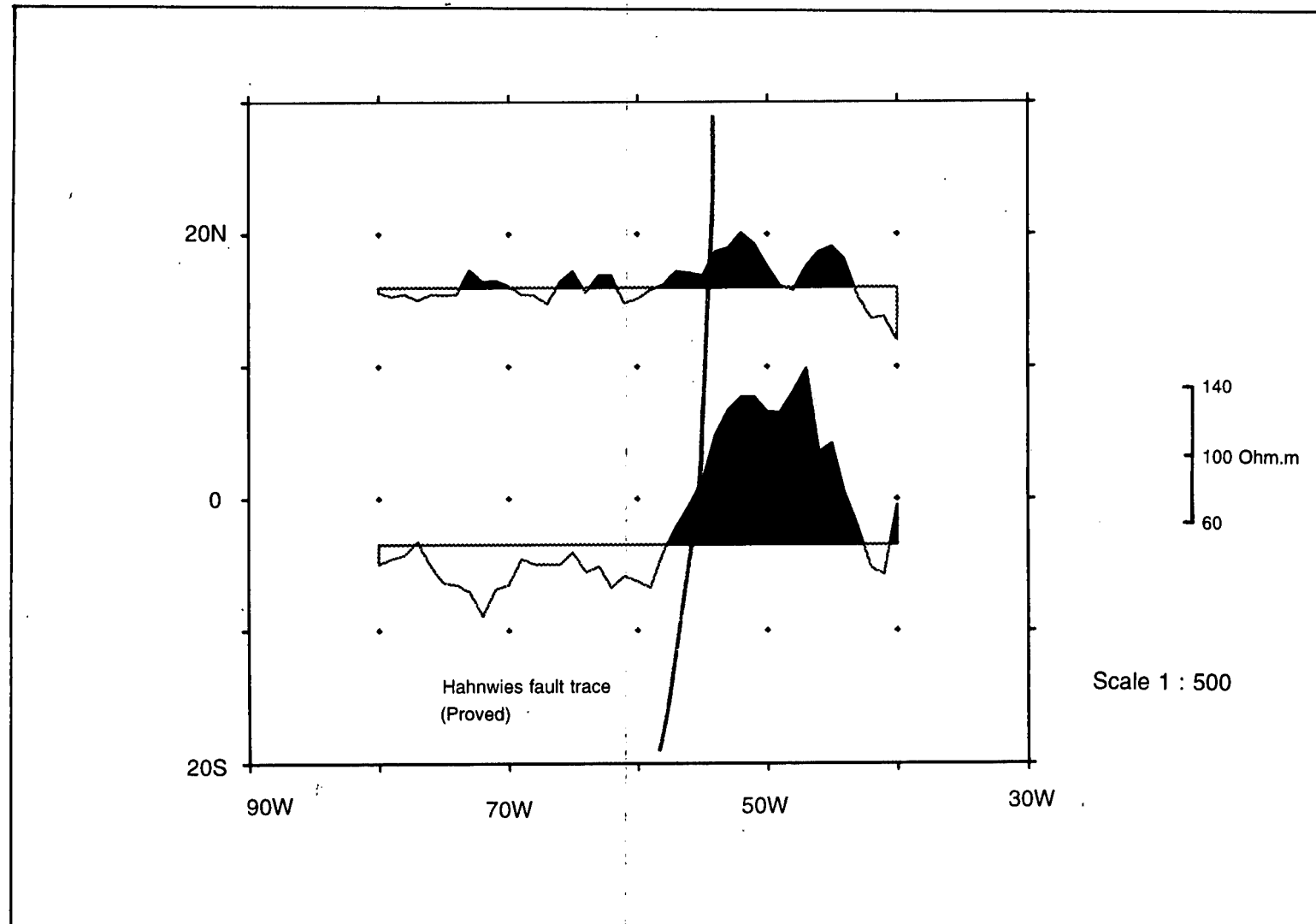


Figure 10 res. Test Site 2.1. Gradient array detail over proven fault trace.

Half - Schlumberger Apparent Resistivity AB = 3 m

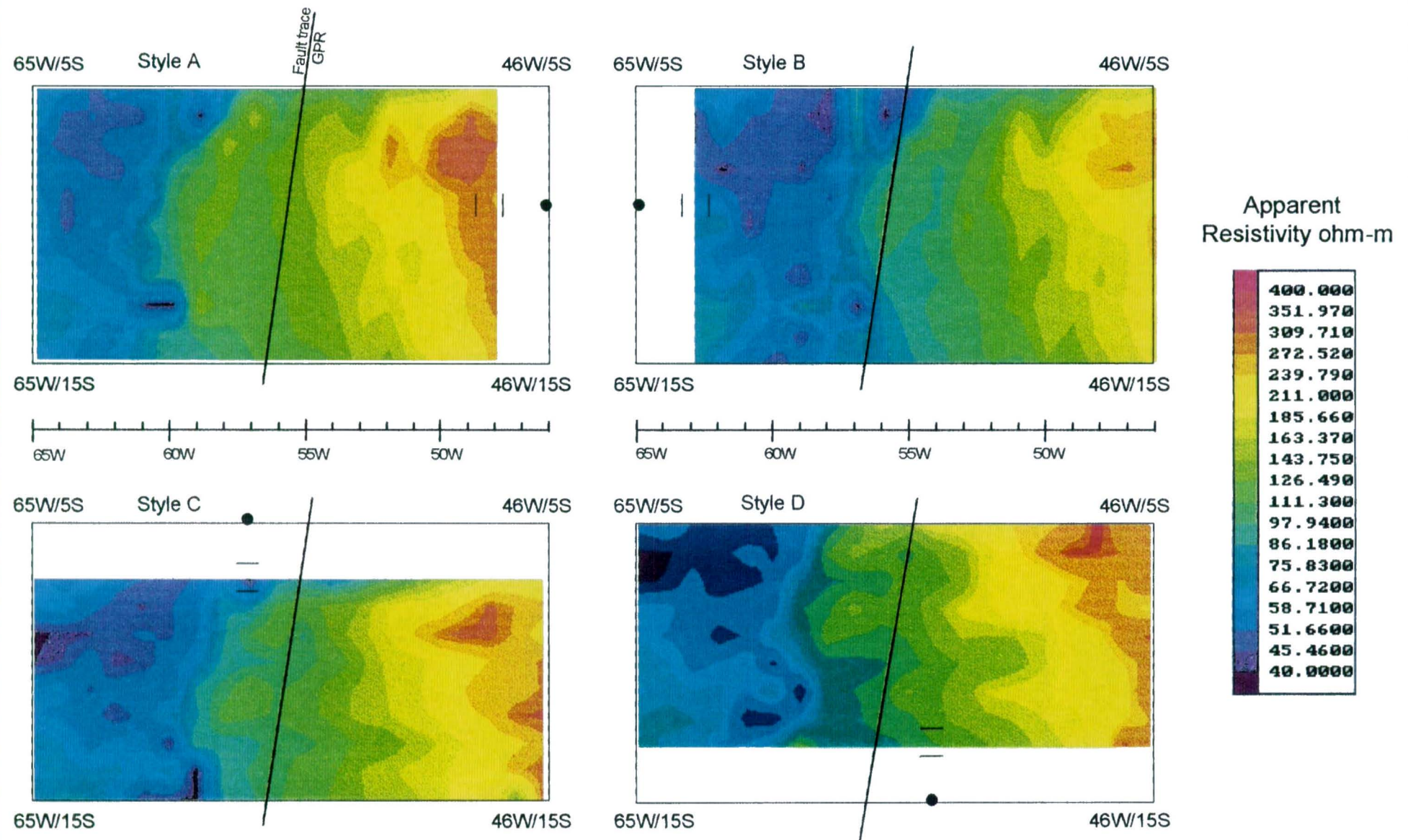


Figure 3 *rsc.* Test Site 2.1. Half Schlumberger apparent resistivity maps for AB=3m.

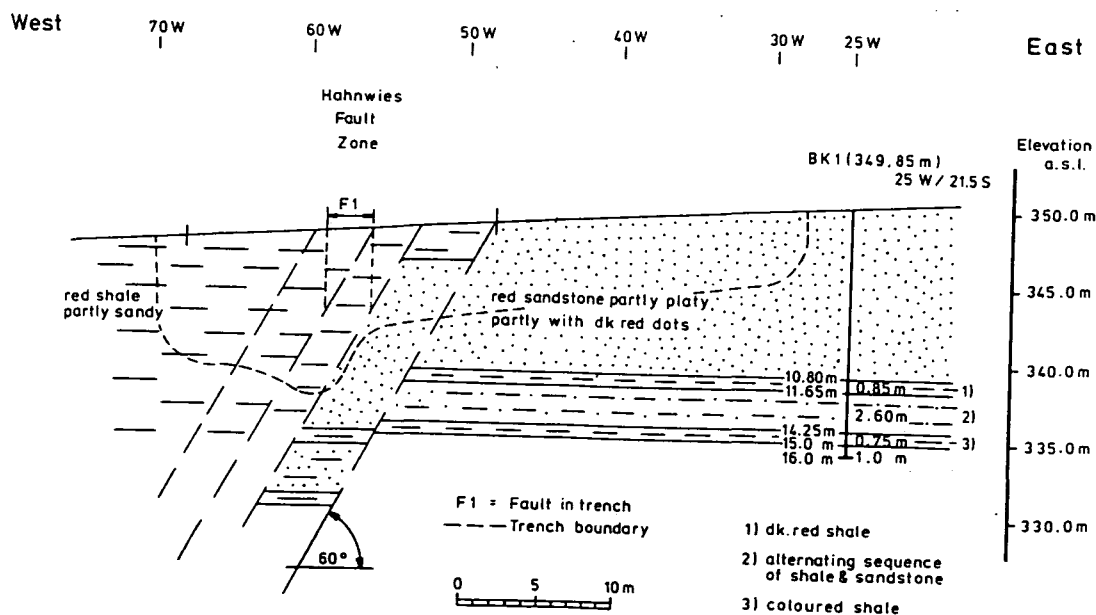
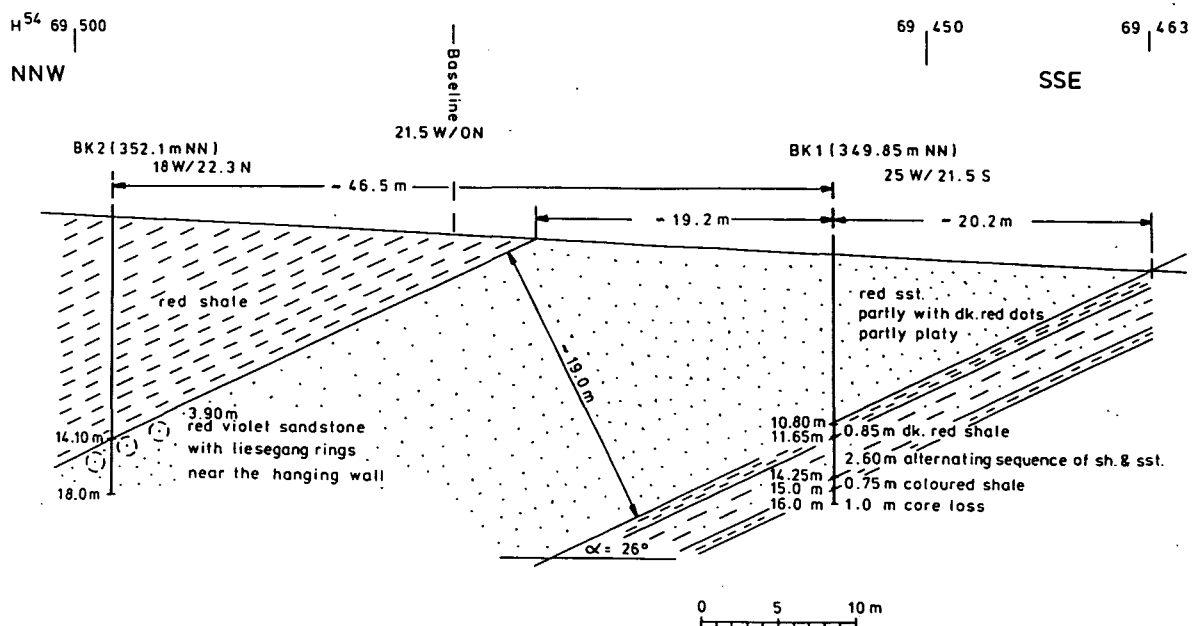


Figure 1 rsc. Test Site 2.1. Geological sections constrained by boreholes B1 and B2 and Trench T1.

Half - Schlumberger Apparent Resistivity

Style B AB =3 and 9 m

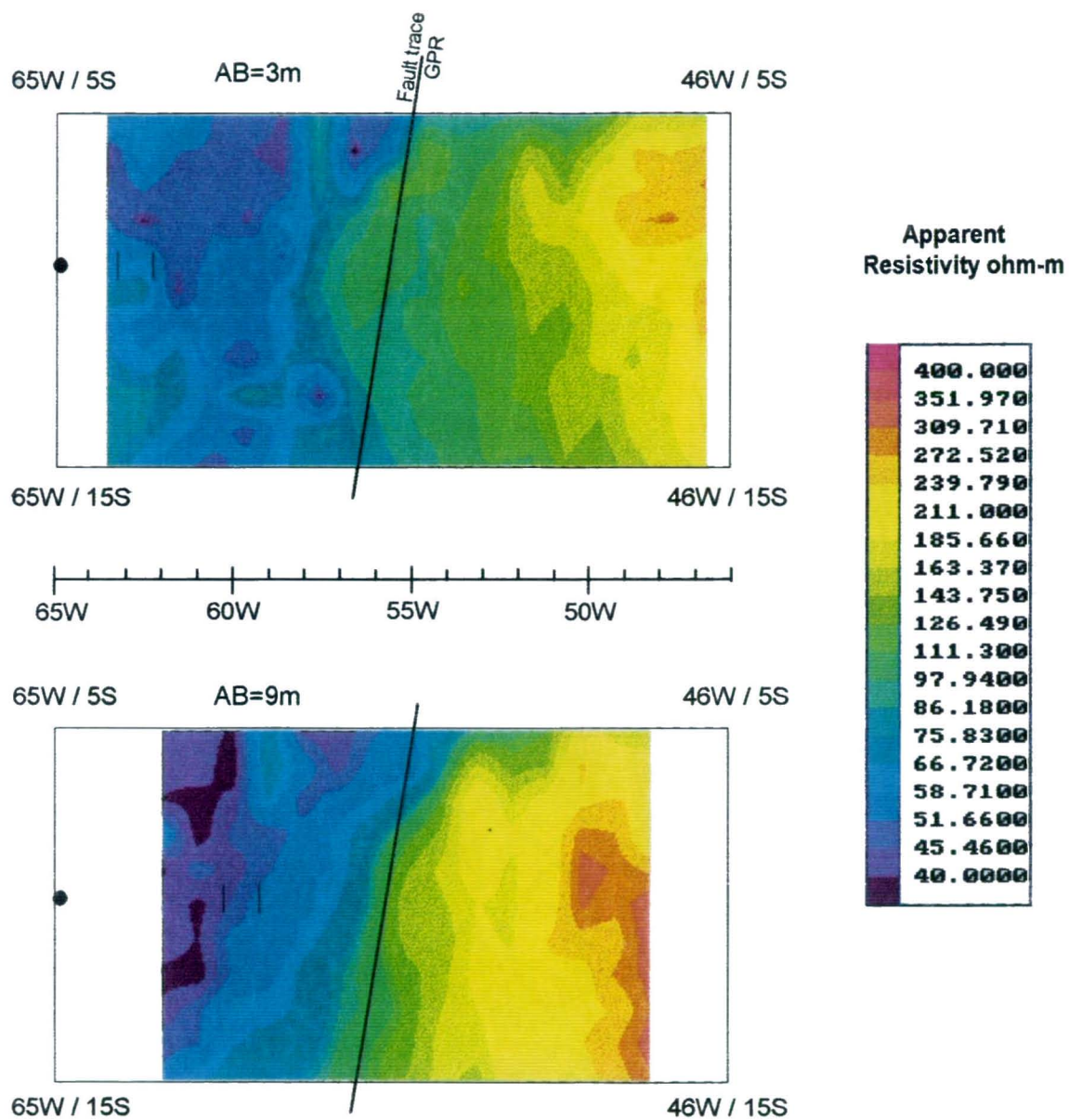


Figure 4 *rsc.* Test Site 2.1. Variable response from different depths of investigation (proportional to AB).

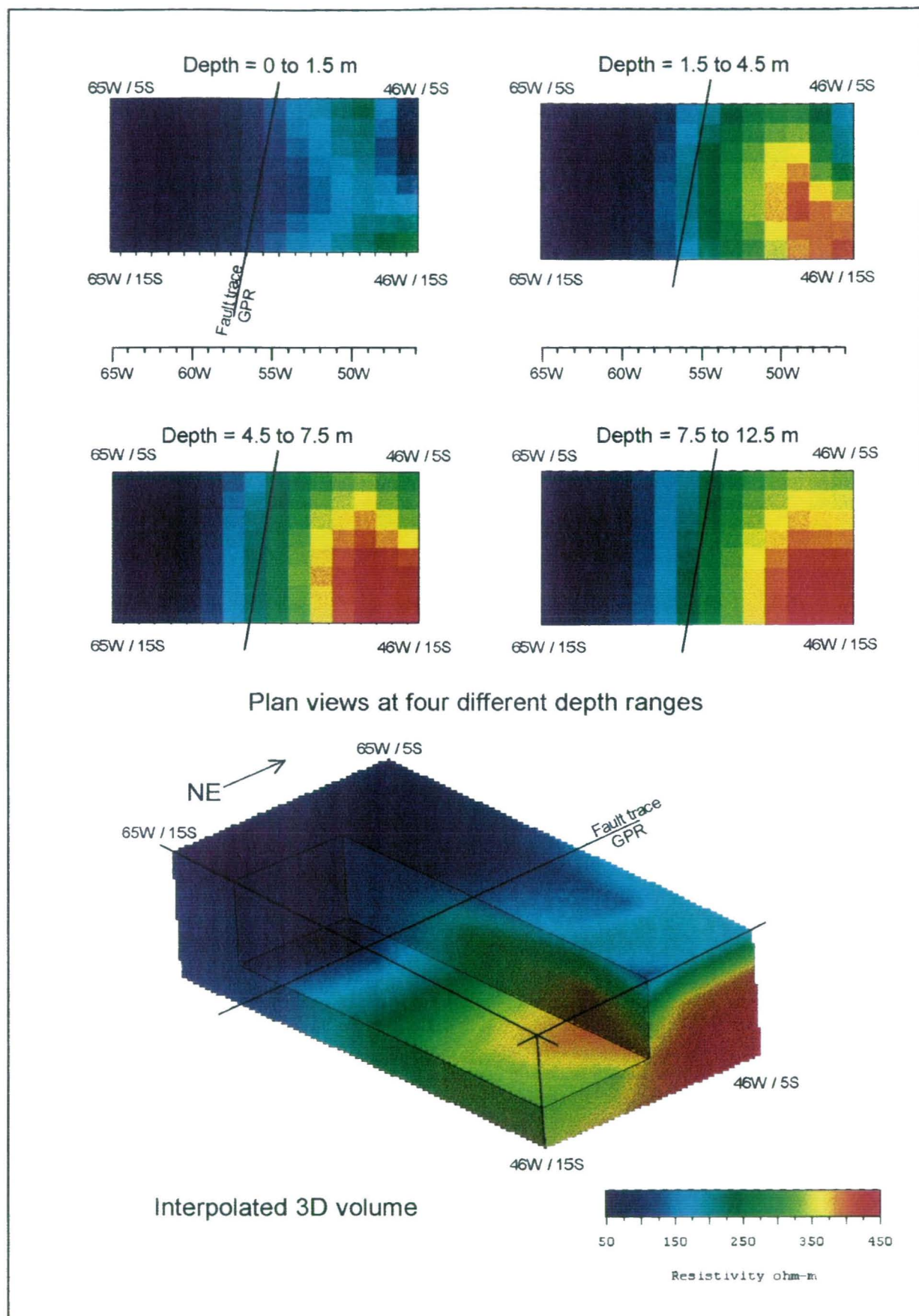
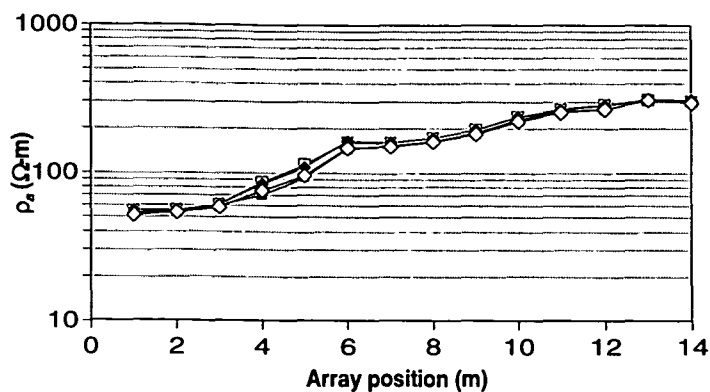
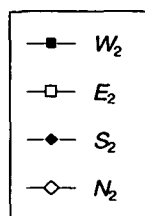
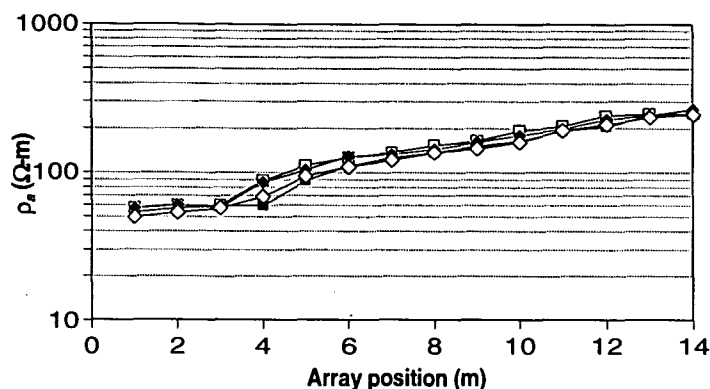


Figure 5 rsc. Test Site 2.1. Smooth inversion of resistivity data illustrating the 3D nature of the geological structure.

Focused apparent resistivity



Pole-pole apparent resistivity



Grid coordinates (line 11S)
63W 61 59 57 55 53 51 49W

Figure 20 *rsc.* Apparent resistivity traverses.

Balance currents

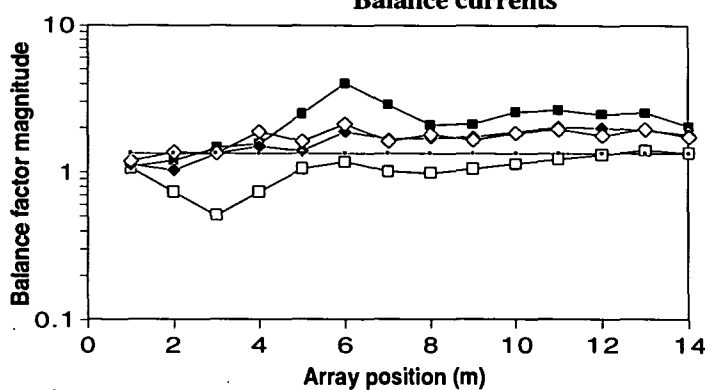
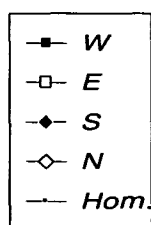


Figure 21 *rsc.* Test Site 2.1. Line 7. Focussed balance factors.

Balance currents

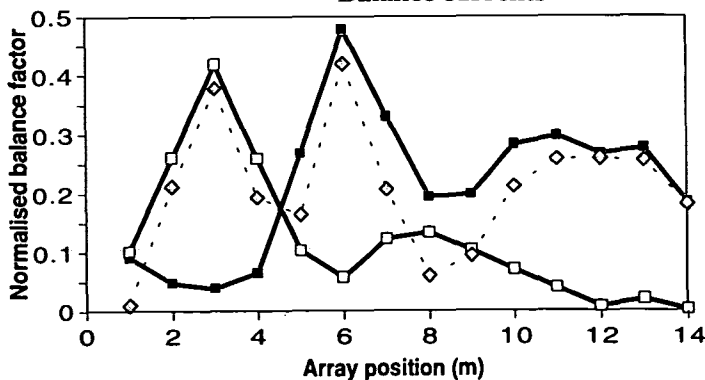
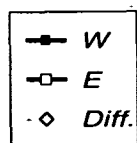


Figure 22 *rsc.* Test Site 2.1. Line 7. Normalised W-E balance factors.

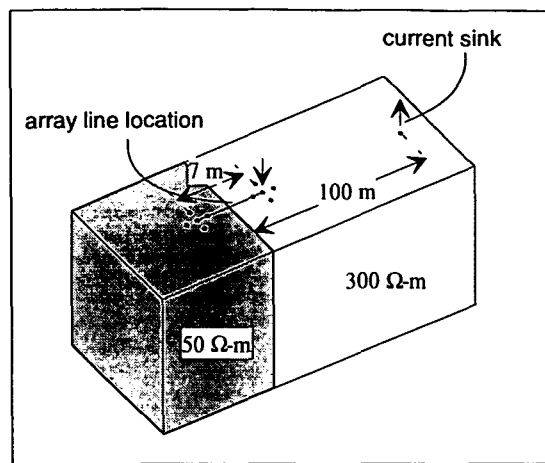


Figure 23 *rsc.* Idealised model of a vertical face.

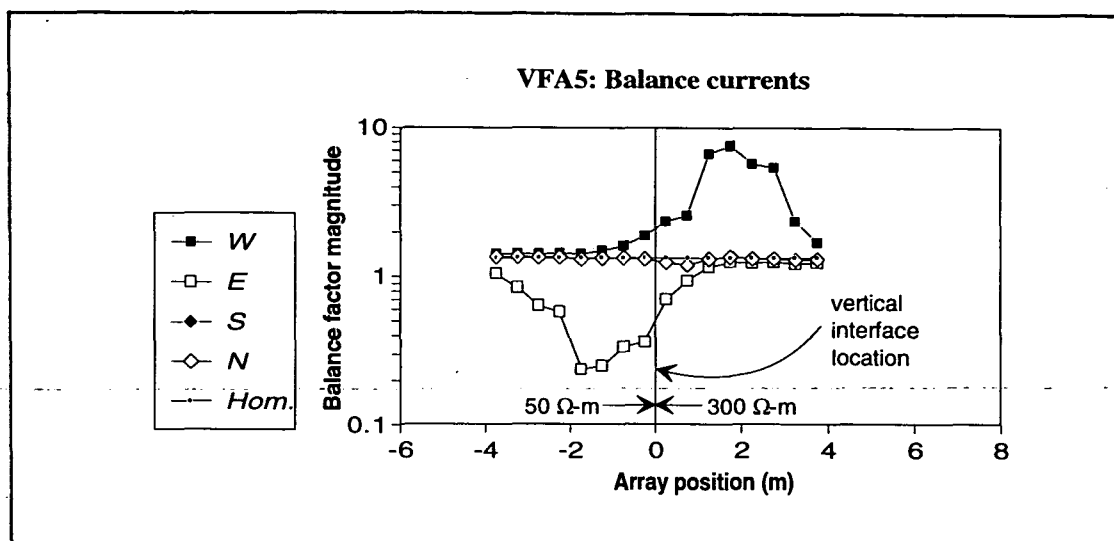


Figure 24 *rsc.* Vertical interface model results, Focussed balance factors.

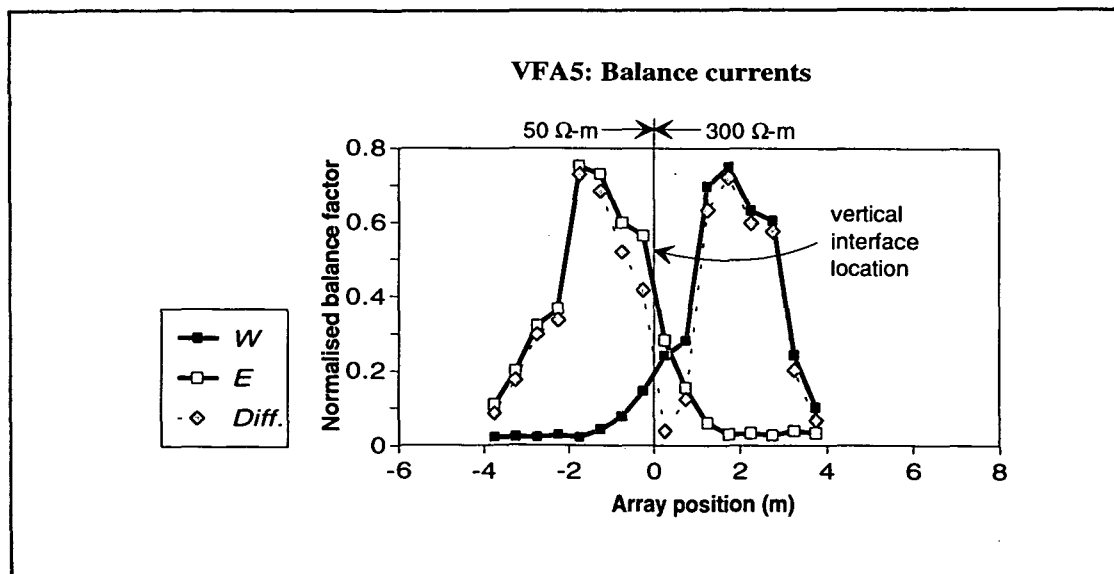


Figure 25 *rsc.* Vertical interface model results, Normalised W-E balance factors.

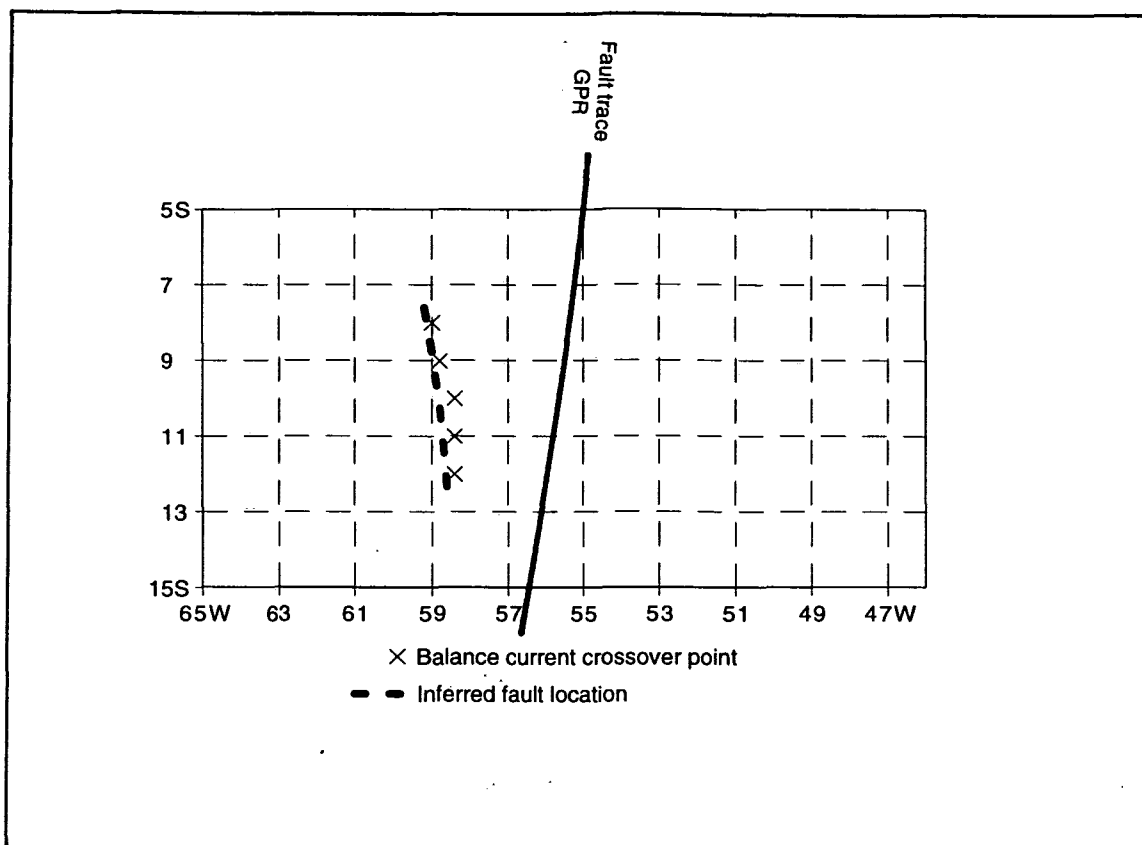
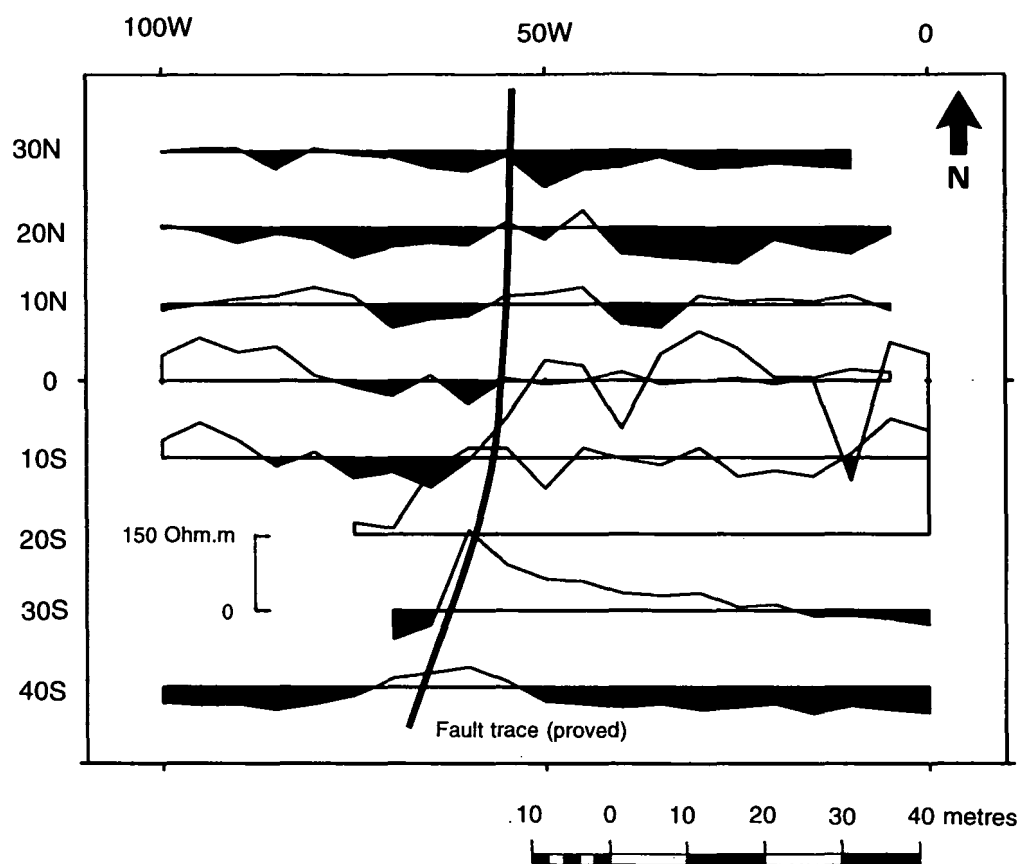
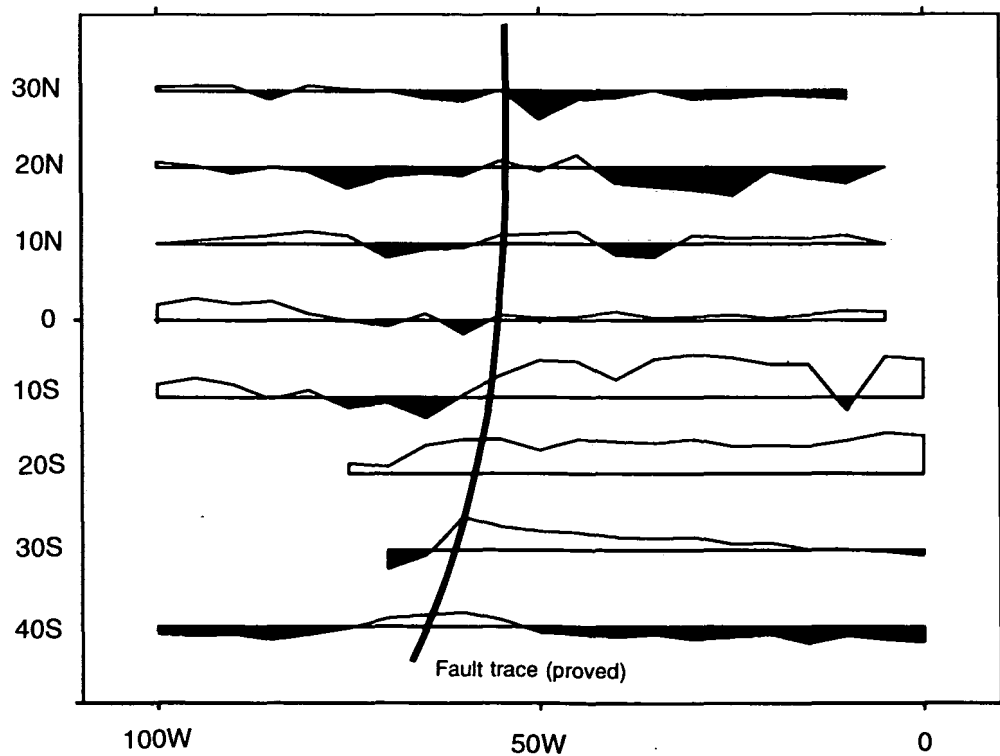


Figure 26 *rsc.* Test Site 2.1. Inferred surface location of fault trace.



A. Arithmetic scale. Scale datum 100 Ohm.m



B. Logarithm scale. Scale datum 90 Ohm.m

Figure 20 *vlf*. Test Site 2.1. VLF R-field (Interuran data) profiles and proved fault trace.

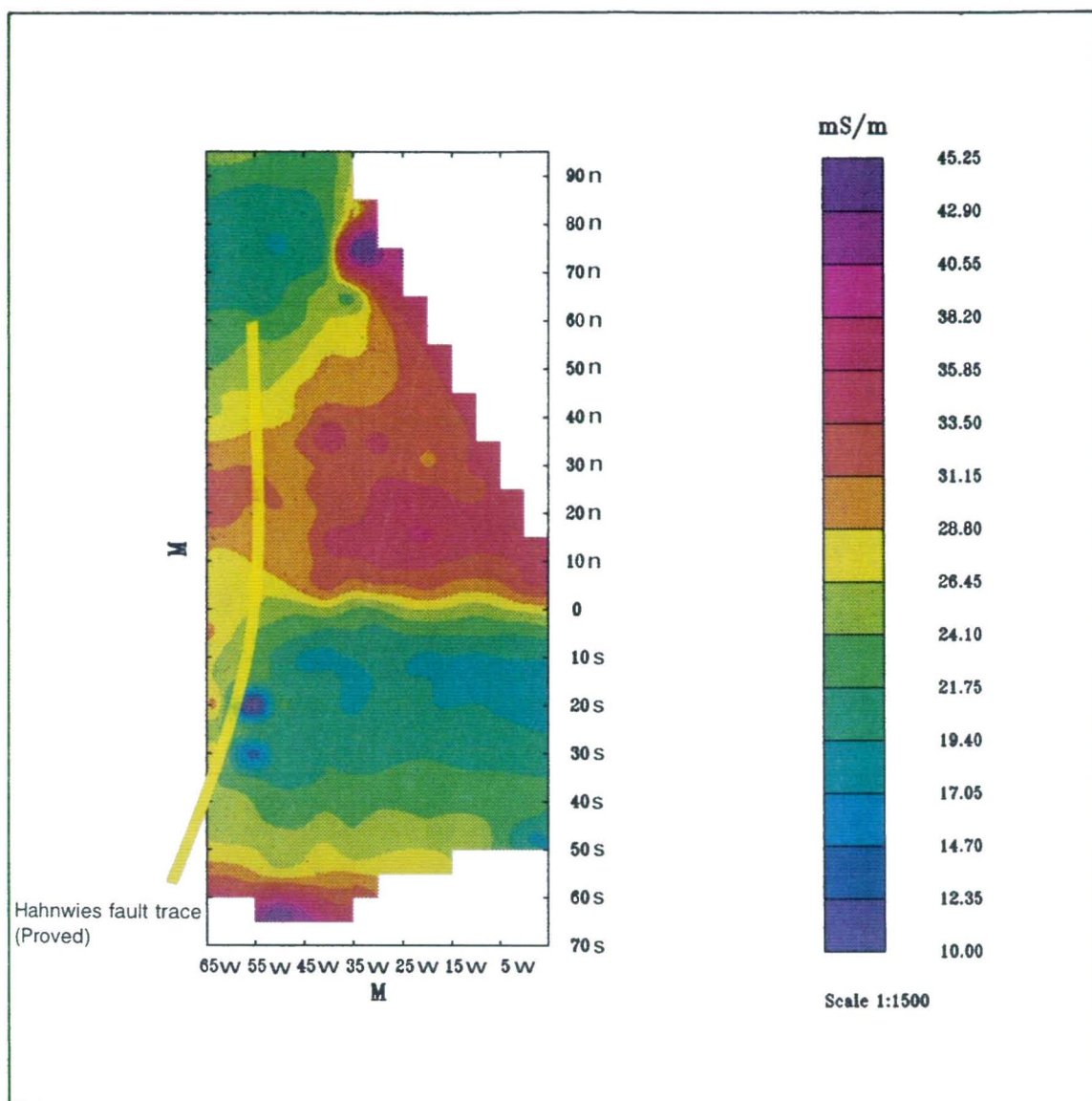


Figure 8 *em.* Test Site 2.1. Apparent conductivity contours (EM31 horizontal dipole).

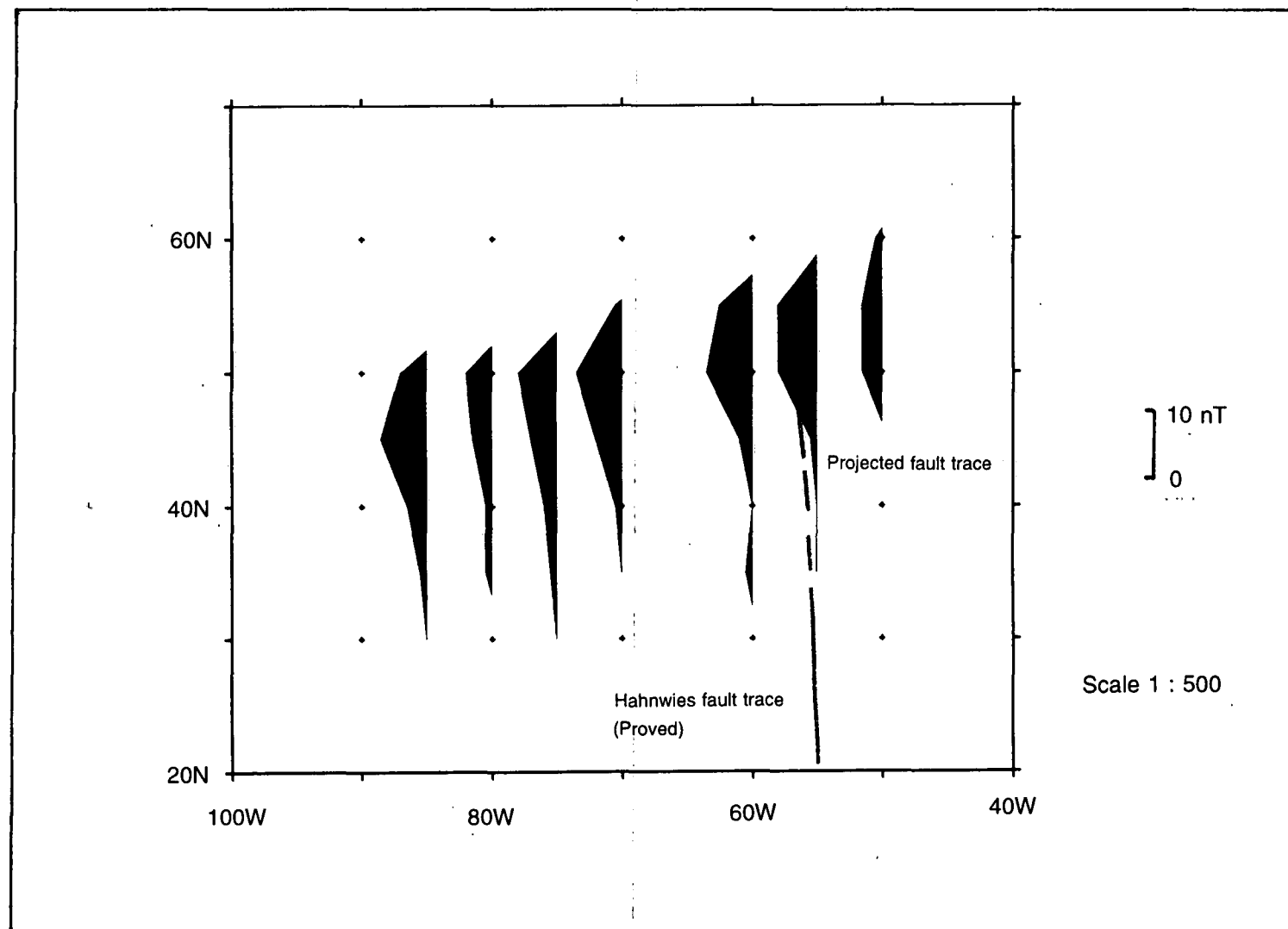


Figure 1 *mag.* Test Site 2.1. Total field magnetic profiles.

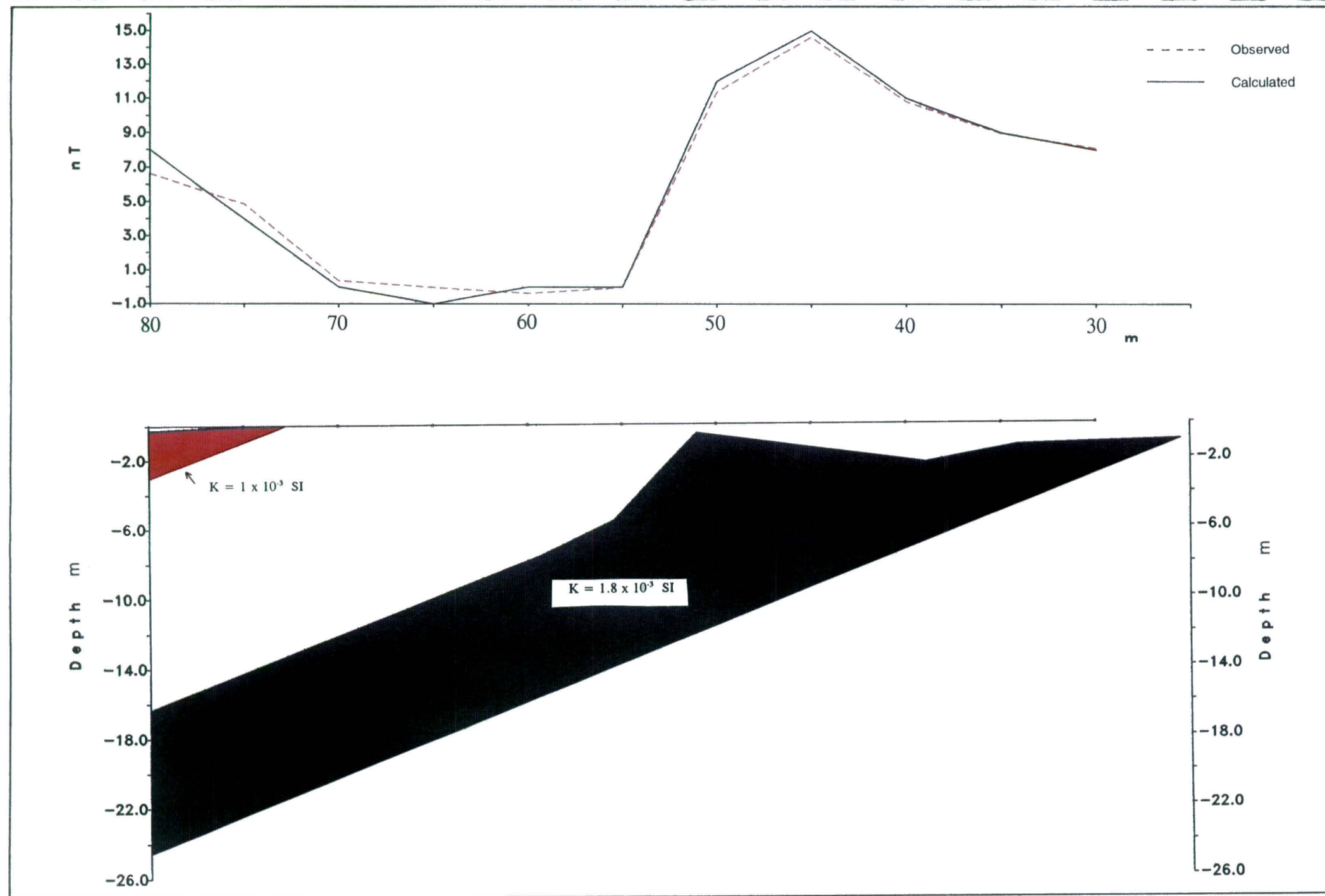


Figure 2 *mag.*

Test Site 2.1. Magnetic model line 85W.

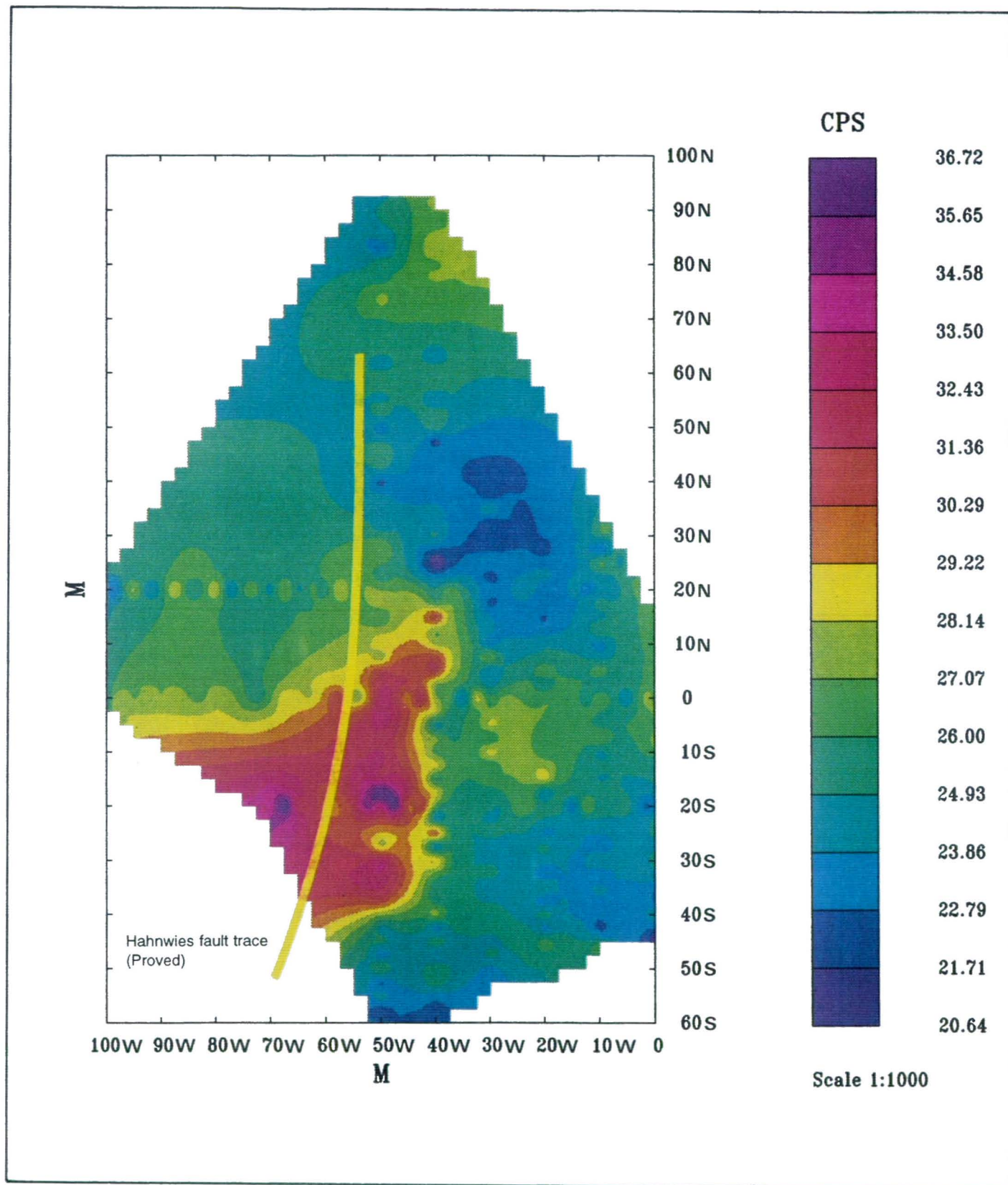


Figure 3 gam.

Test Site 2.1. Natural gamma surface mapping.

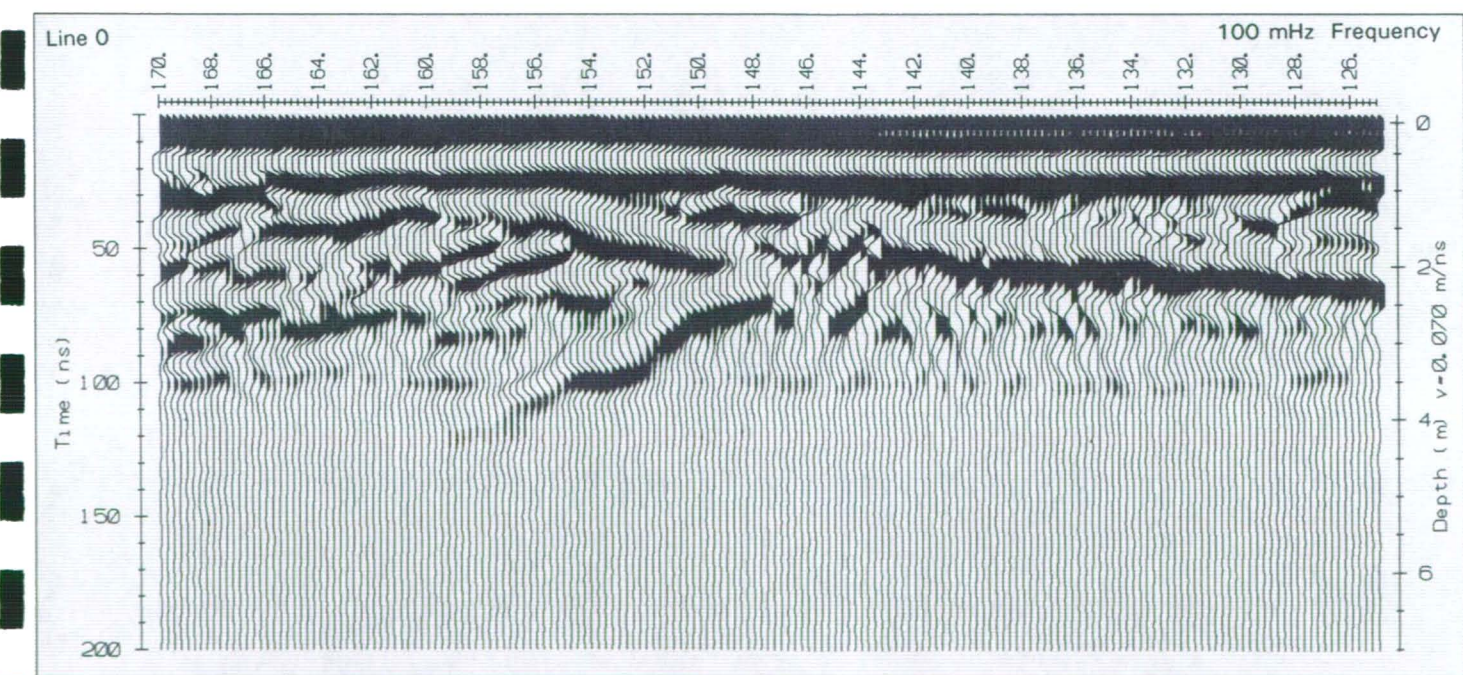
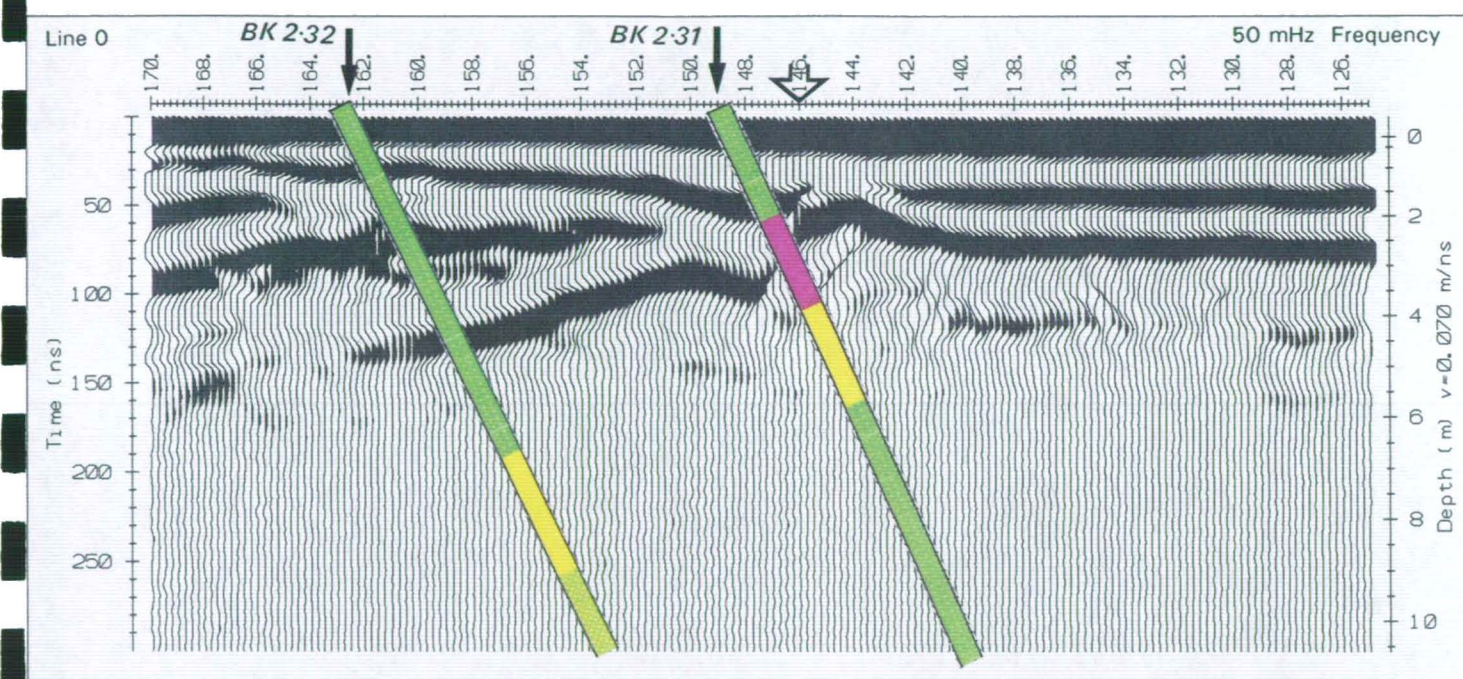
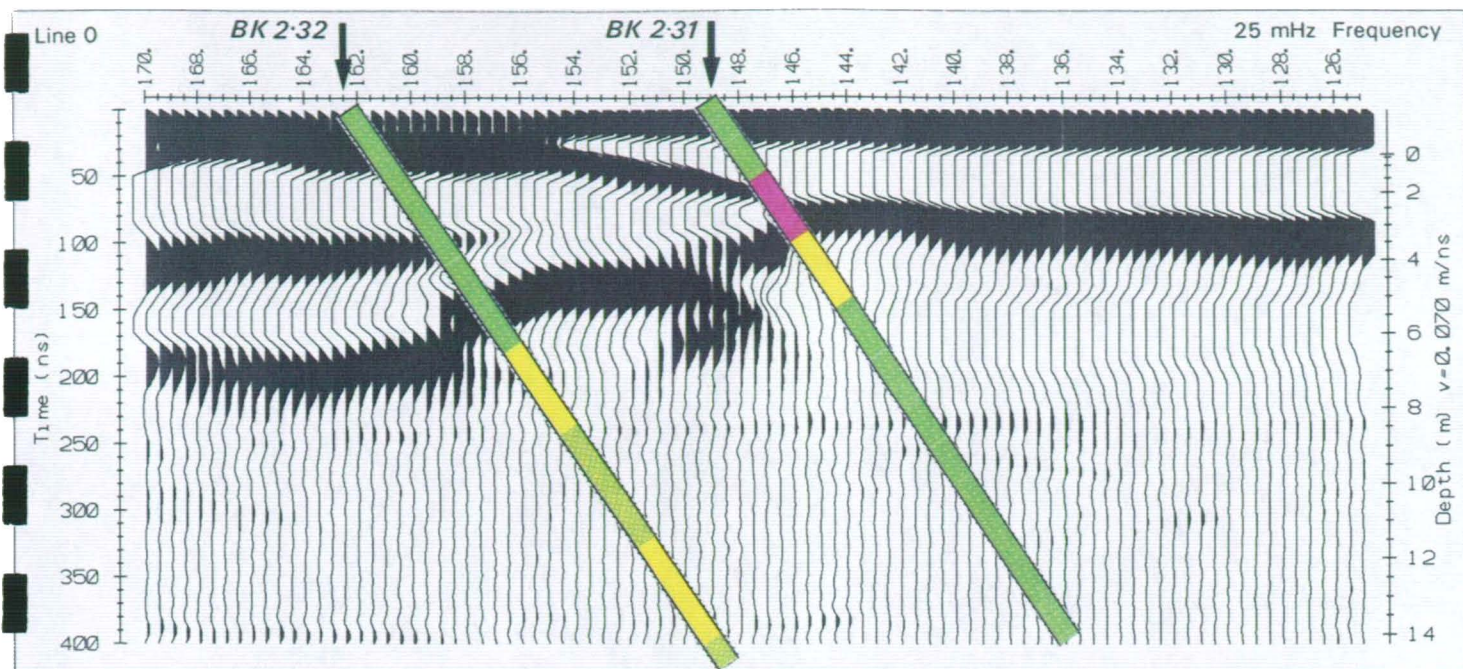


Figure 21 *gpr*. Test Site 2.3. GPR profile for line 0. Comparison of 25, 50, and 100 MHz antennae frequencies.

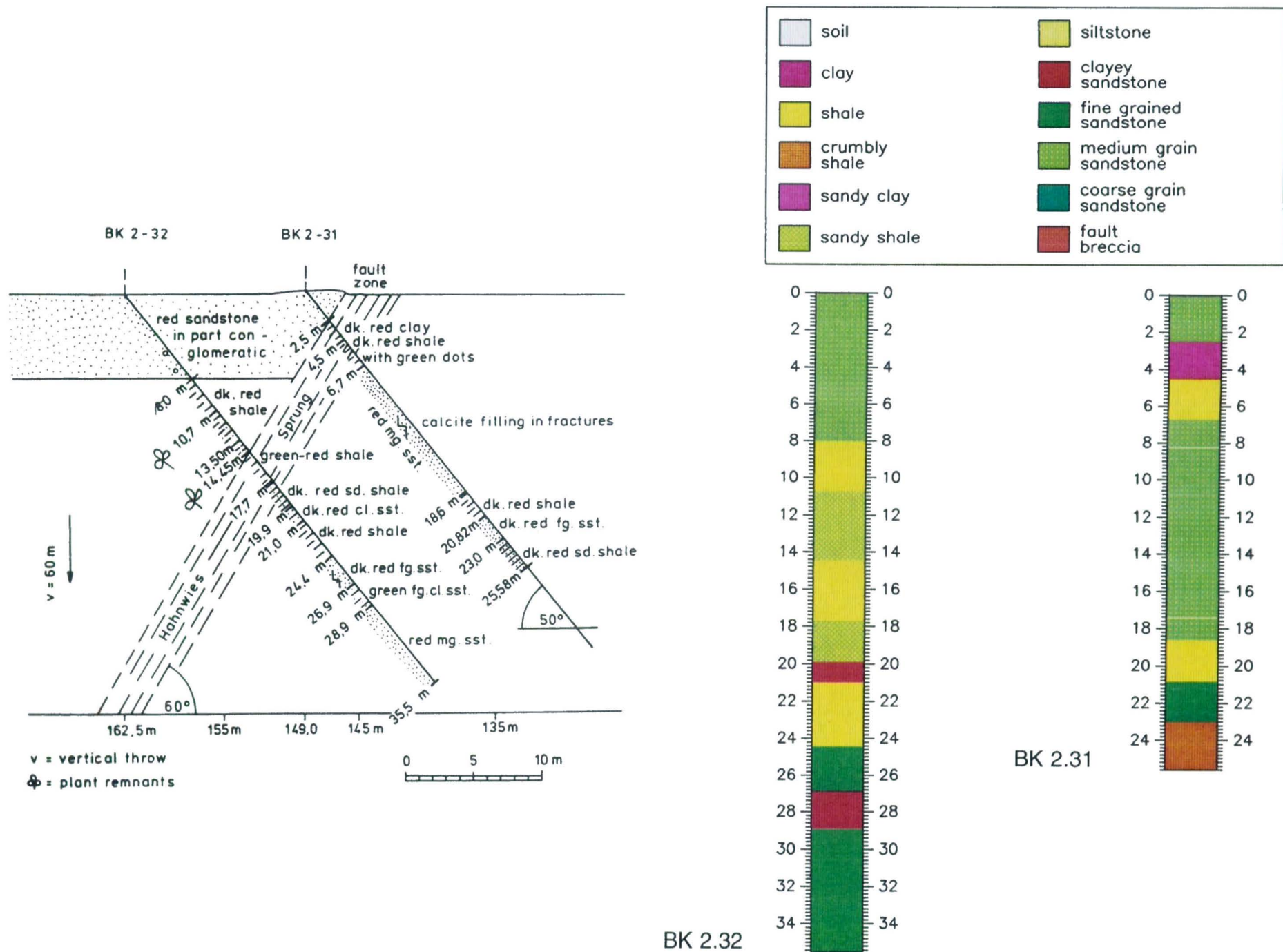


Figure 20. Test Site 2.3. Geological section: boreholes BK2.31 and BK2.32.

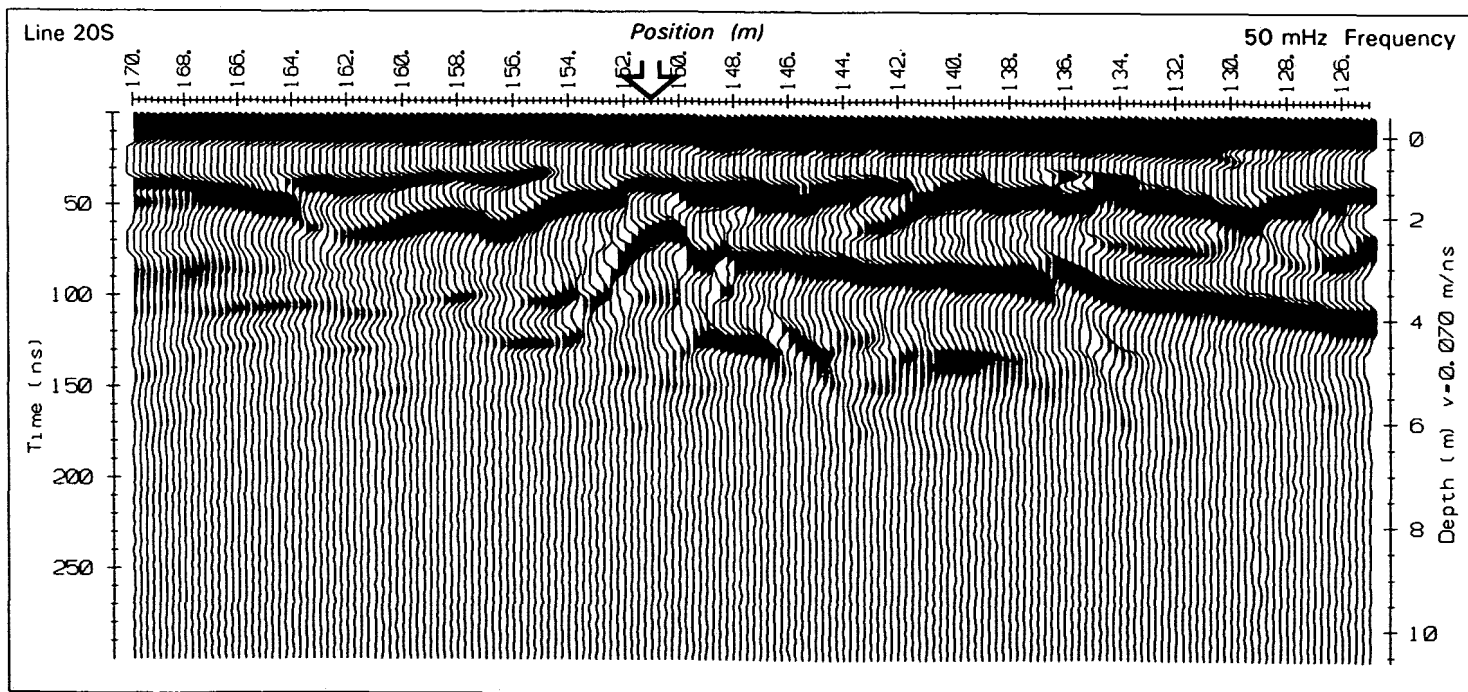
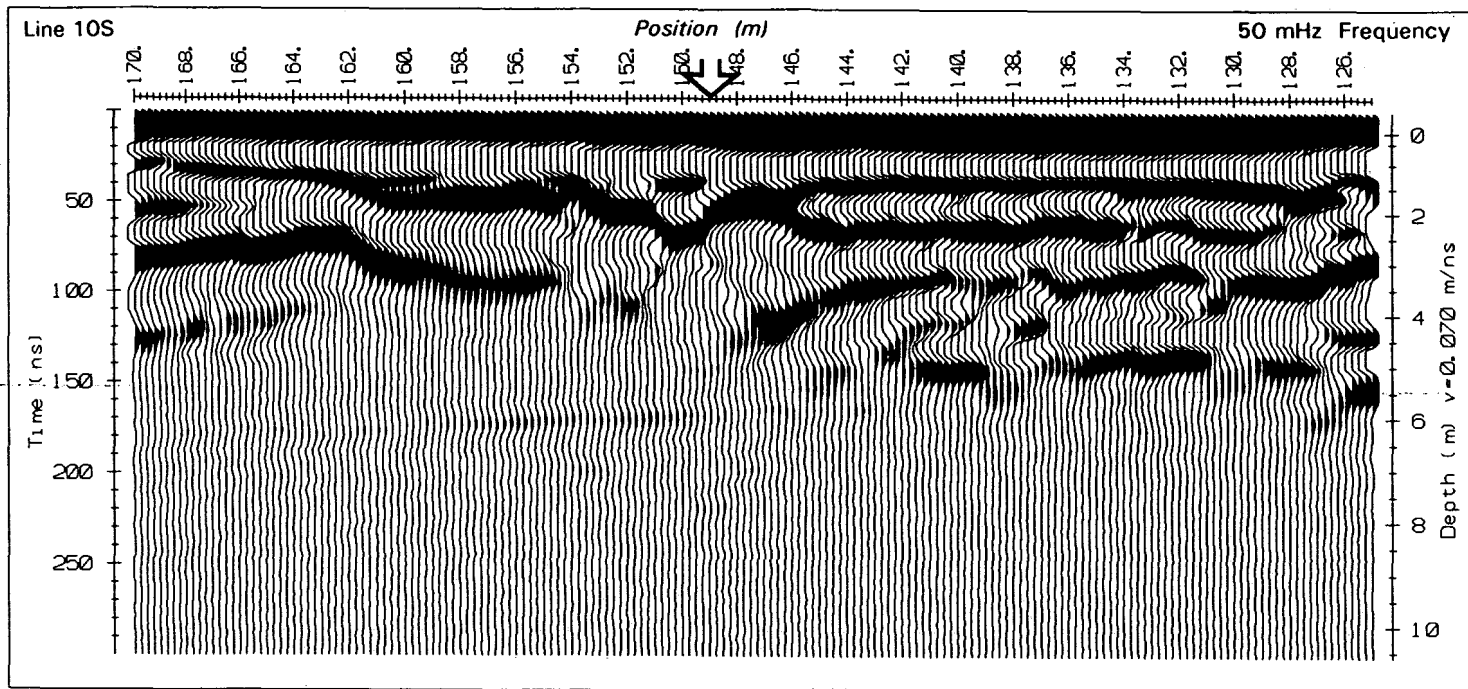
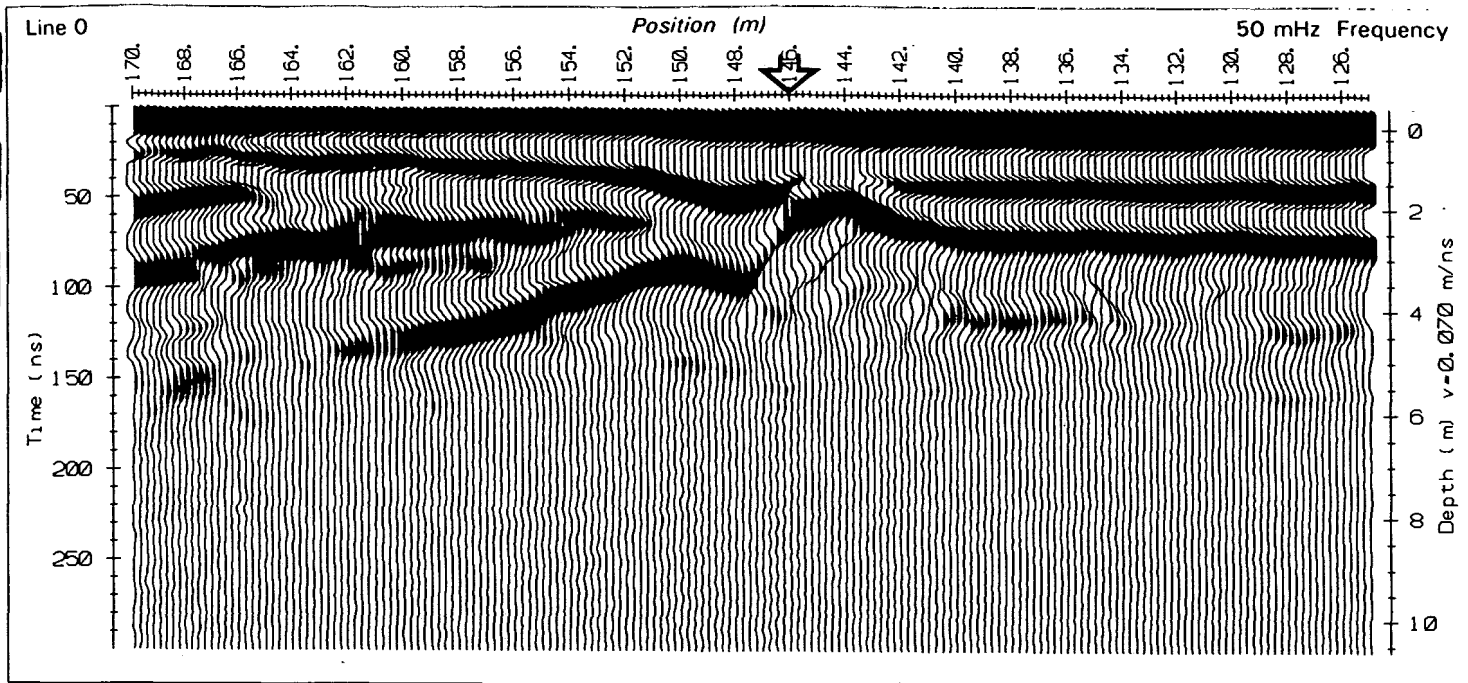


Figure 22 *gpr*. Test Site 2.3. GPR profiles for lines 0, 10S, and 20S. 50 MHz antennae.

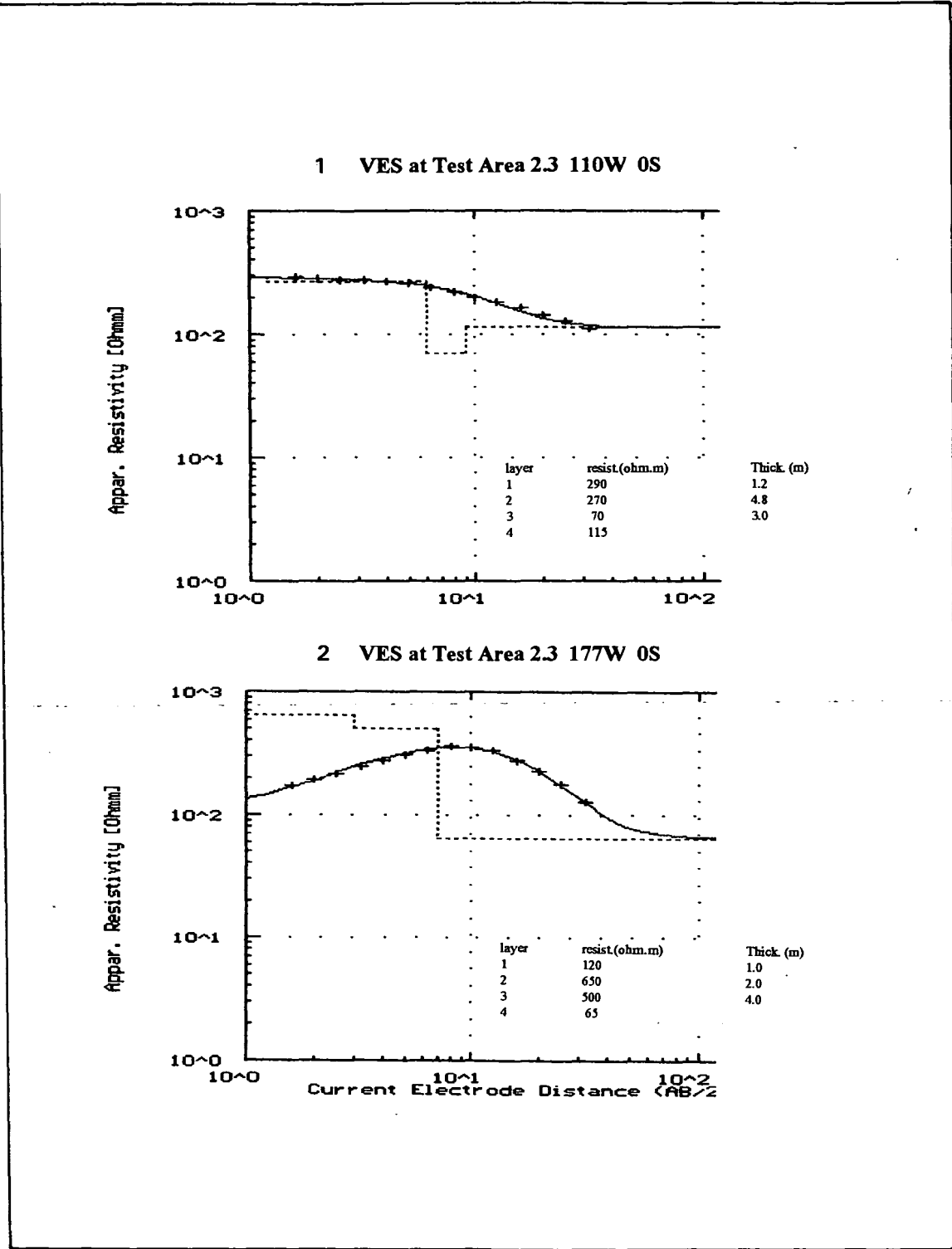


Figure 11 res.

Test Site 2.3. Interpretation of VES 1, and 2.

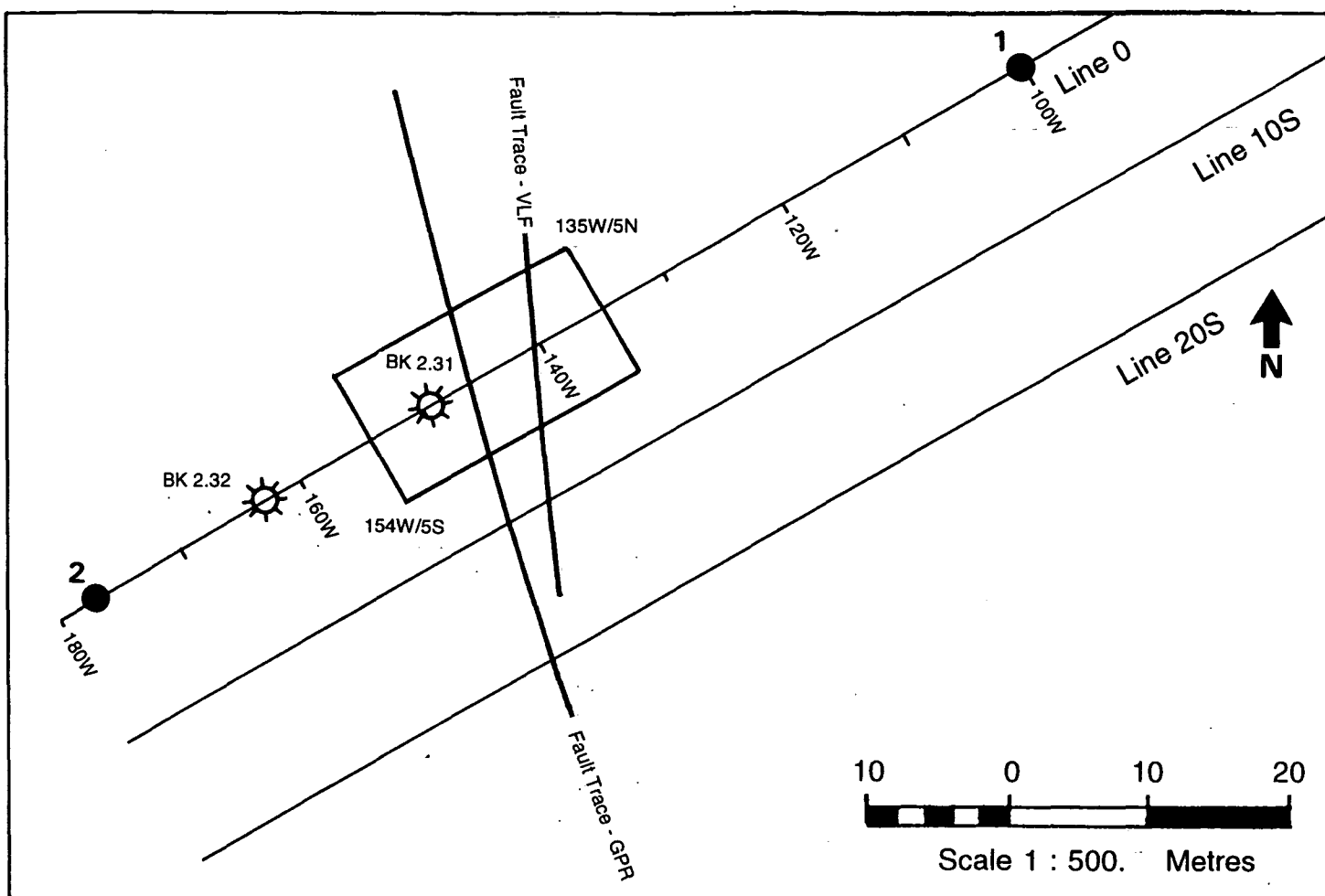


Figure 32. *rsc.* Test Site 2.3. Plan (partial) of site showing location of RESCAN grid.

Half - Schlumberger Apparent Resistivity Style B AB = 3 and 9 m

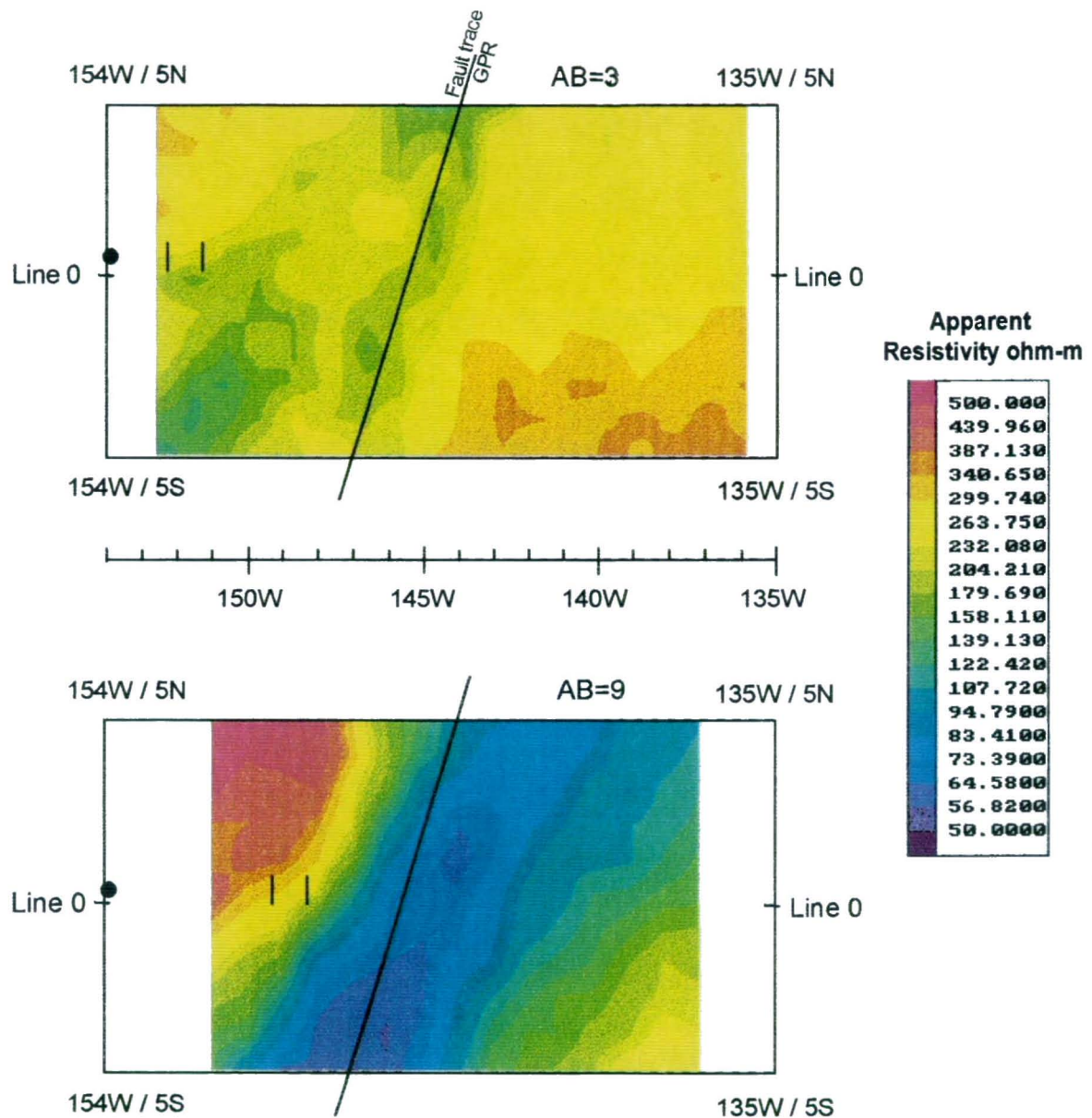


Figure 6 *rsc.* Test Site 2.3. Apparent resistivity maps for two depths of investigation.

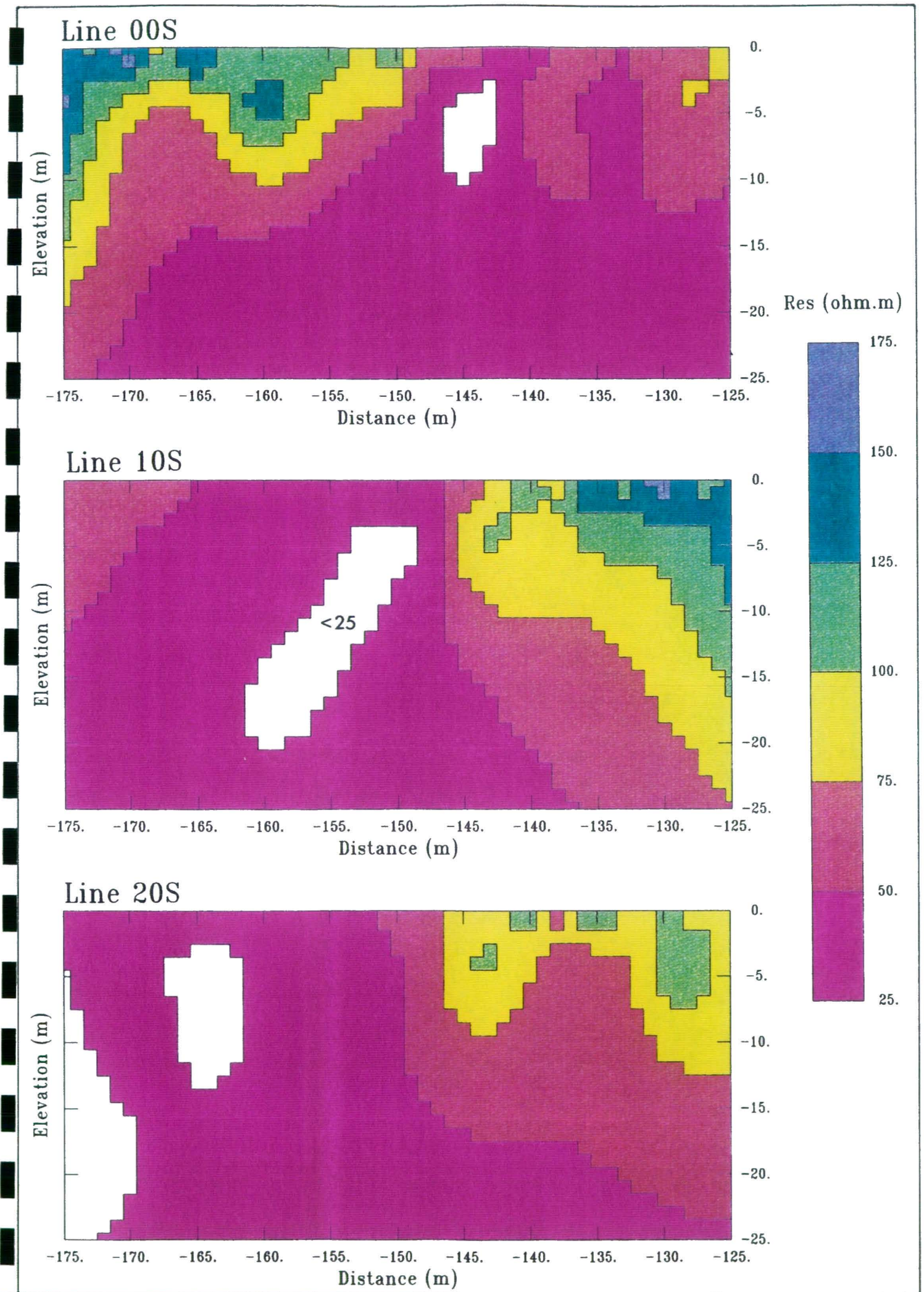


Figure 21 *vlf*. Test Site 2.3. Modelled resistivity cross sections for lines 0, 10S, and 20S.

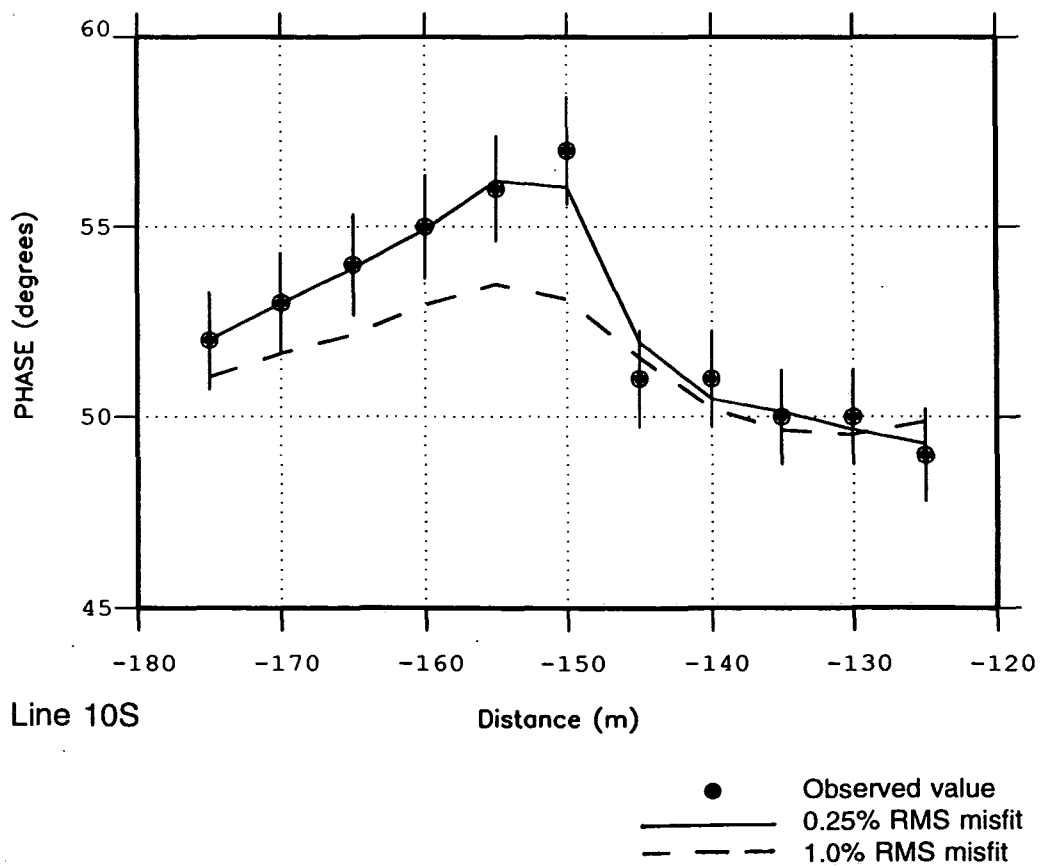
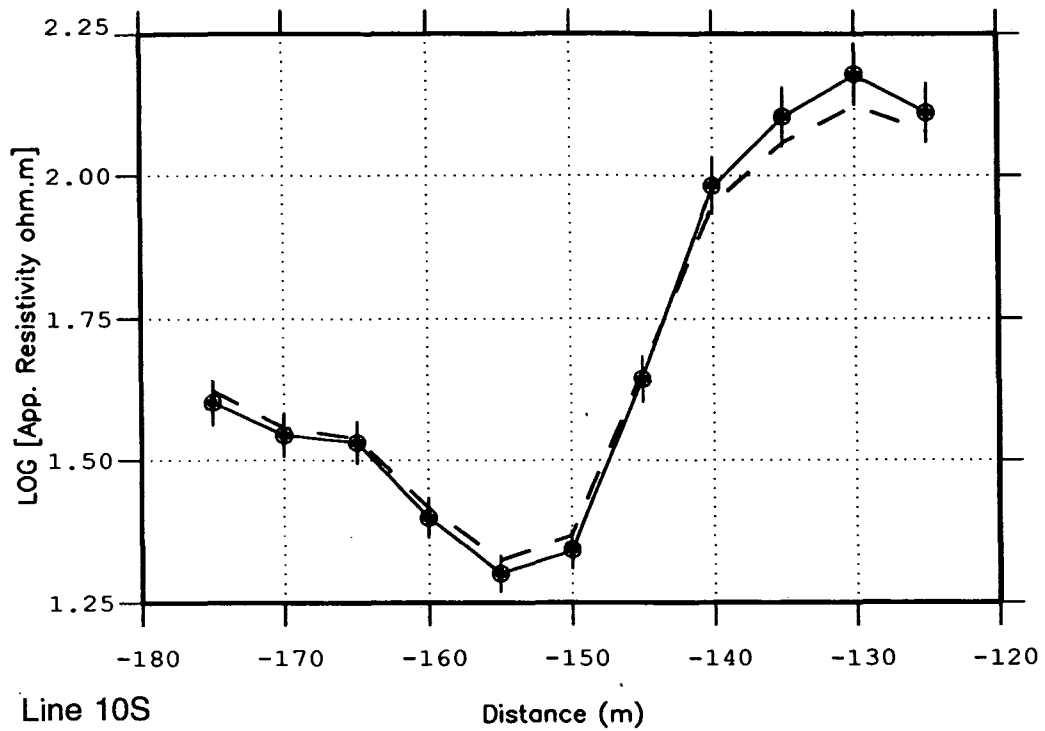


Figure 22 *vlf*. Test Site 2.3. Occam inversion: levels of fit of models to observed data.

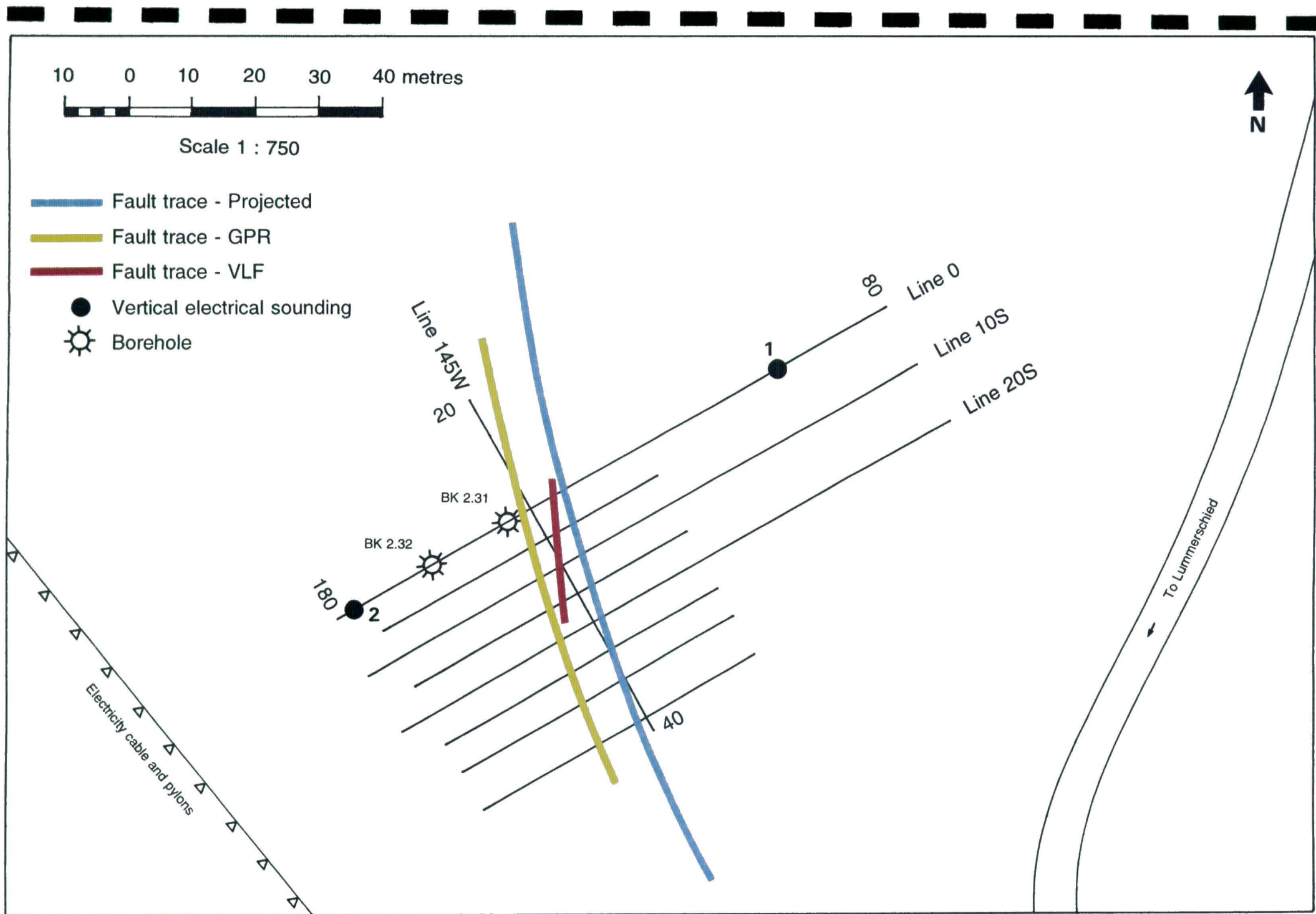
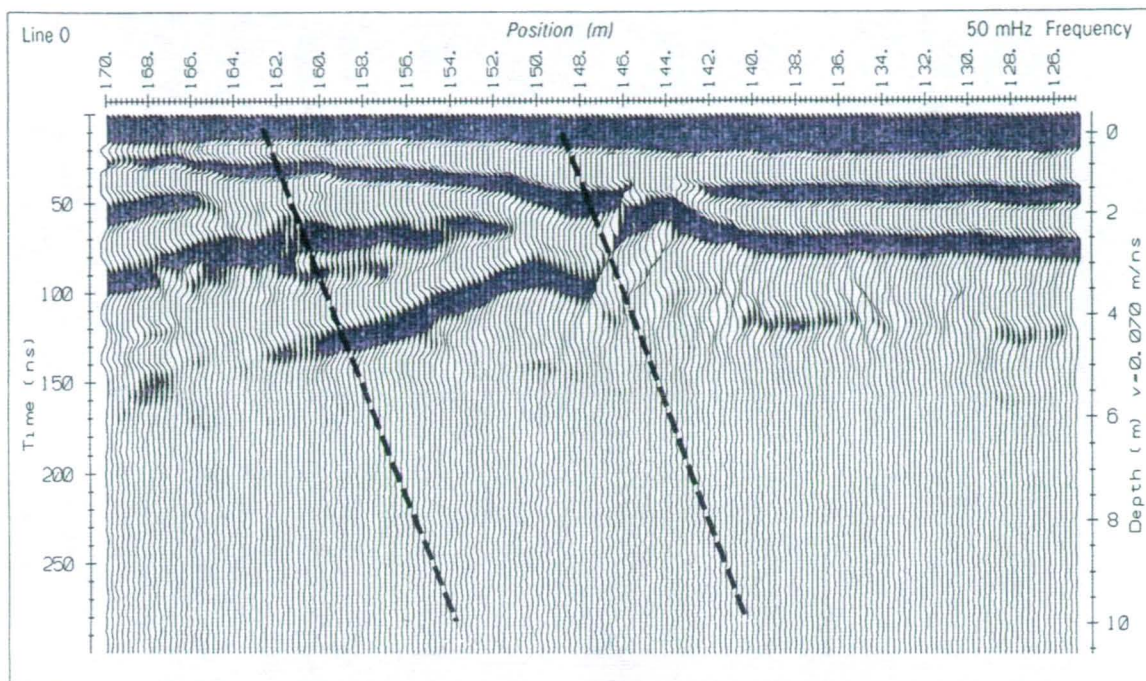
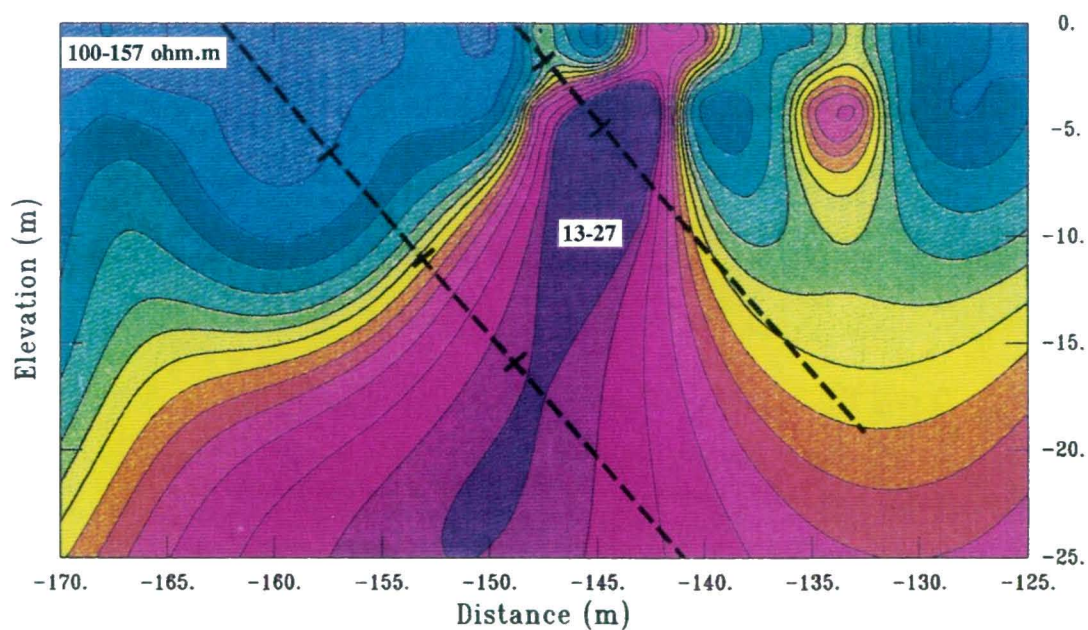


Figure 19. Test Site 2.3. Geophysical grid, borehole locations, and interpretation.



Ground Probing Radar (50MHz)
 $dx = 0.25m$, V.E. $\times 2.3$



VLF (16kHz) Resistivity Model (Equal Area Colour)
 $dx = 5m$, True Scale

Figure 23 vlf. Test Site 2.3. Coincident GPR and VLF resistivity cross sections for line 10S.

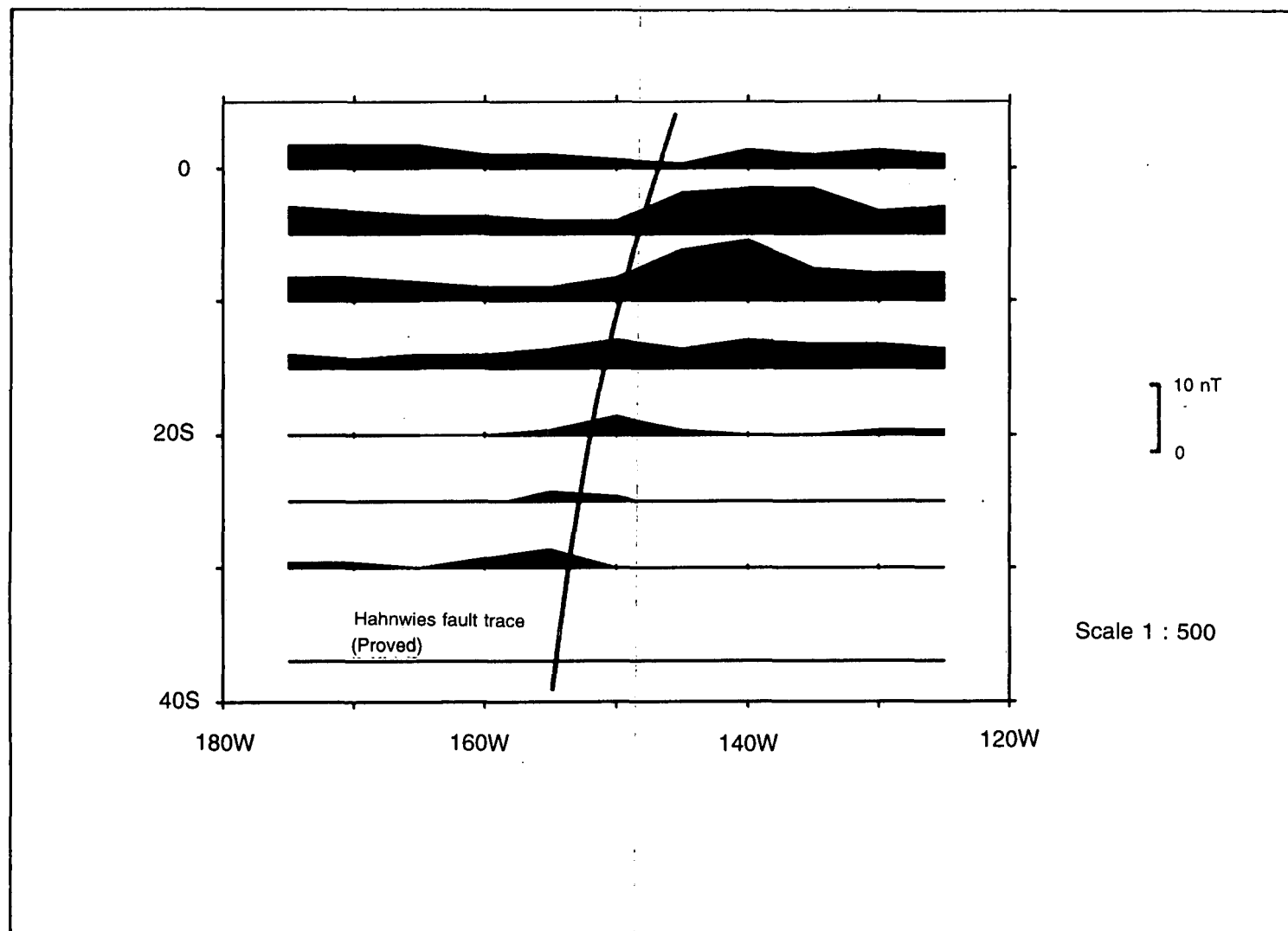


Figure 3 *mag.* Test Site 2.3. Total field magnetic profiles.

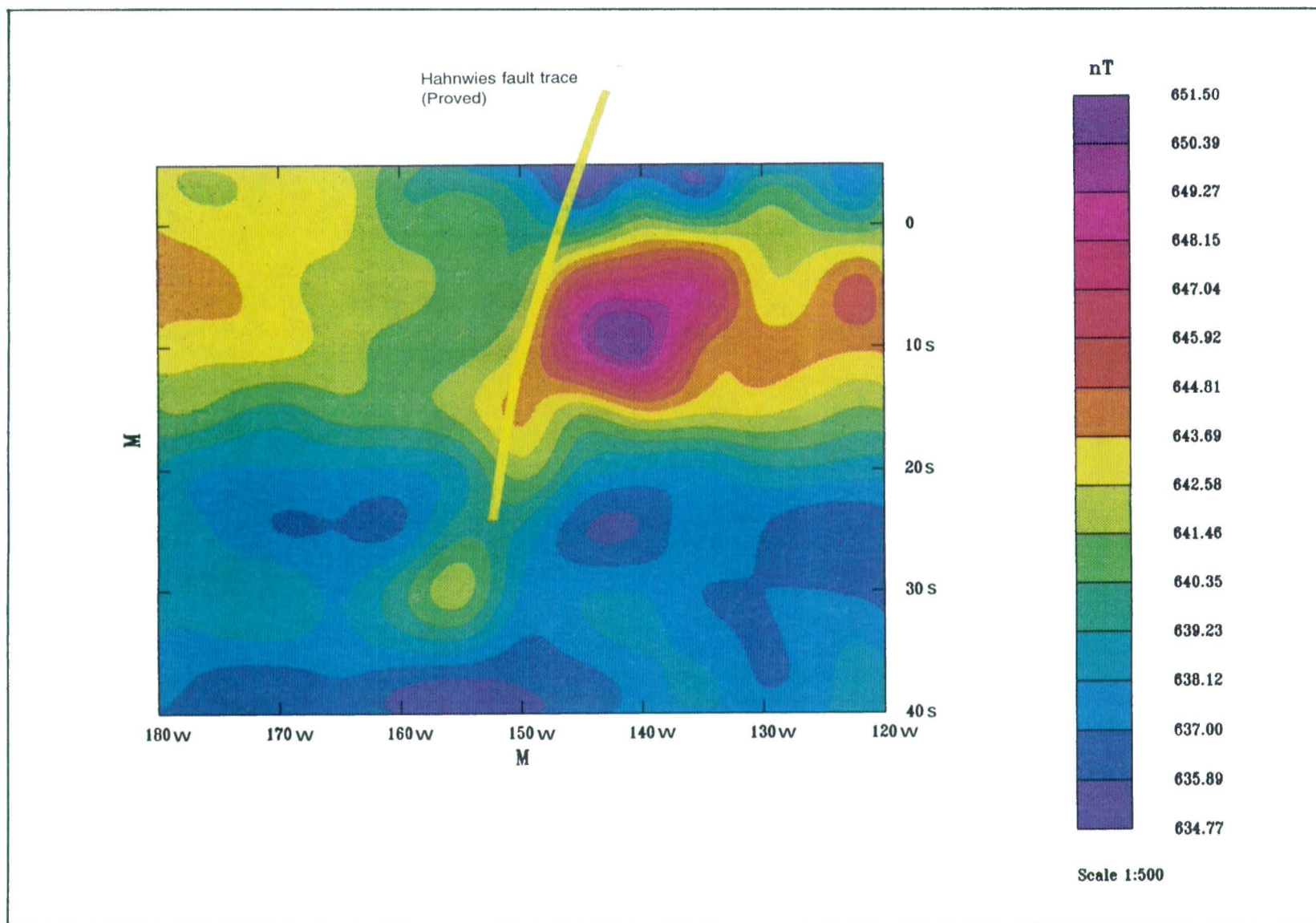


Figure 4 *mag.* Test Site 2.3. Total field magnetic contours.

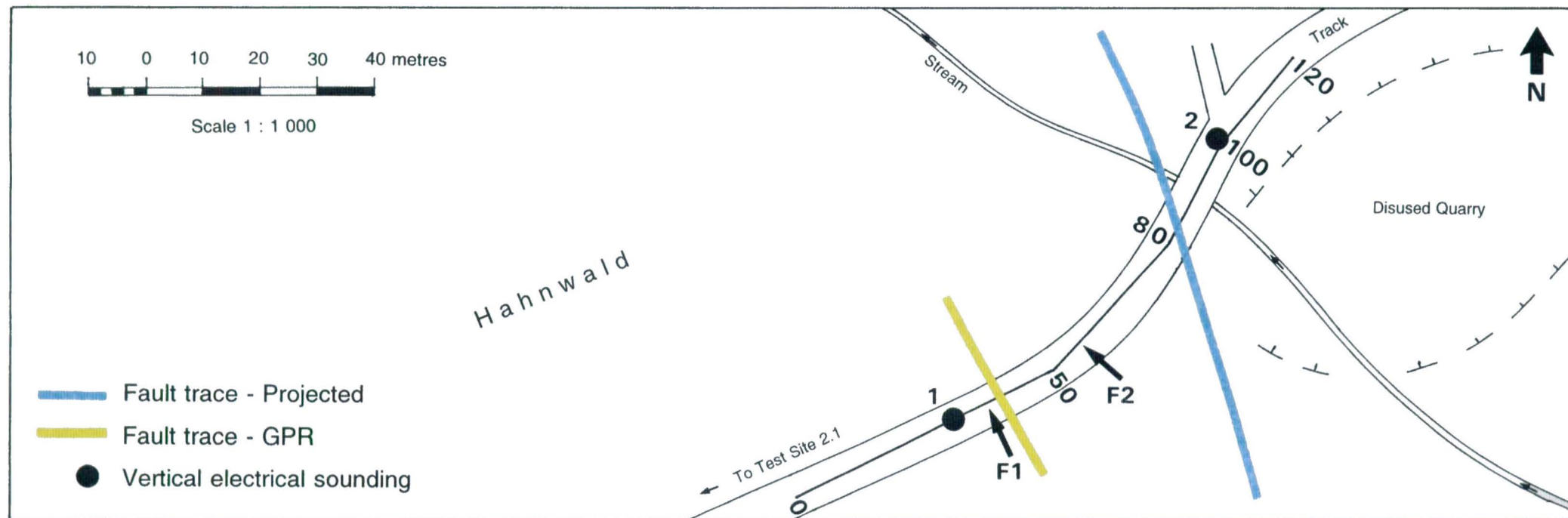


Figure 21. Test Site Hahnwald. Hahnwald traverse and interpretation.

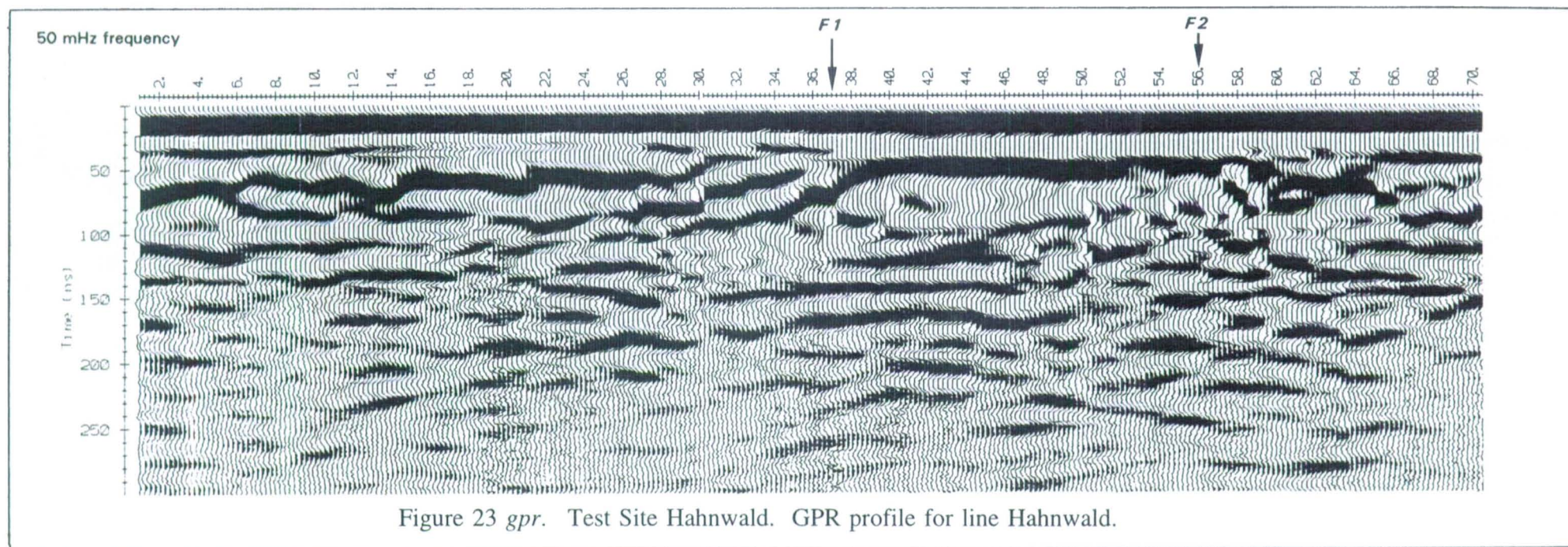
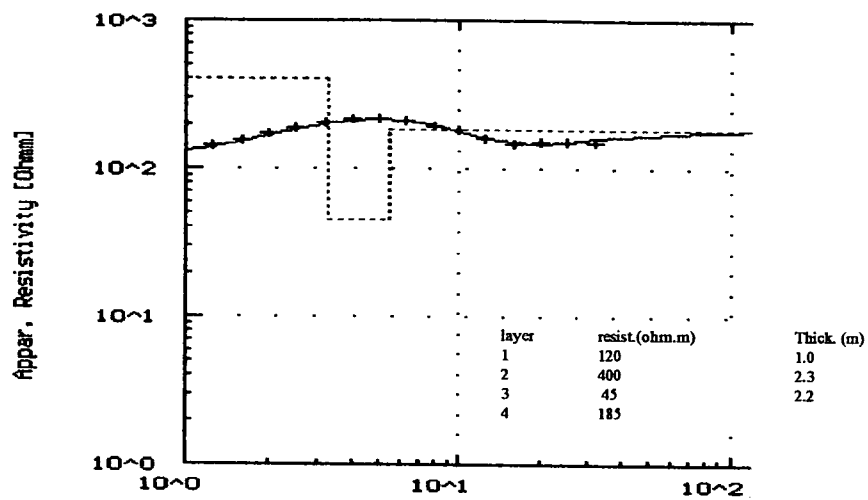


Figure 23 *gpr*. Test Site Hahnwald. GPR profile for line Hahnwald.

1 VES on Hahnwald track at 30E



2 VES on Hahnwald track at 100E

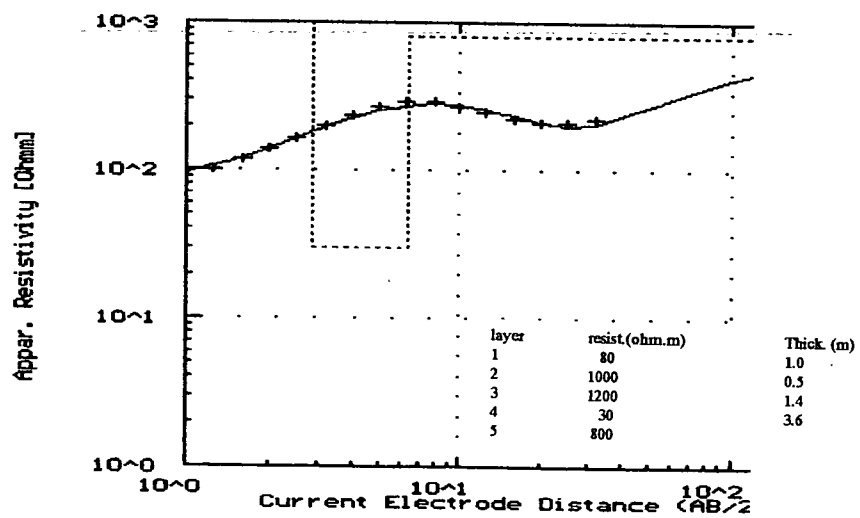


Figure 12 res.

Hahnwald track. Interpretation of VES 1, and 2.

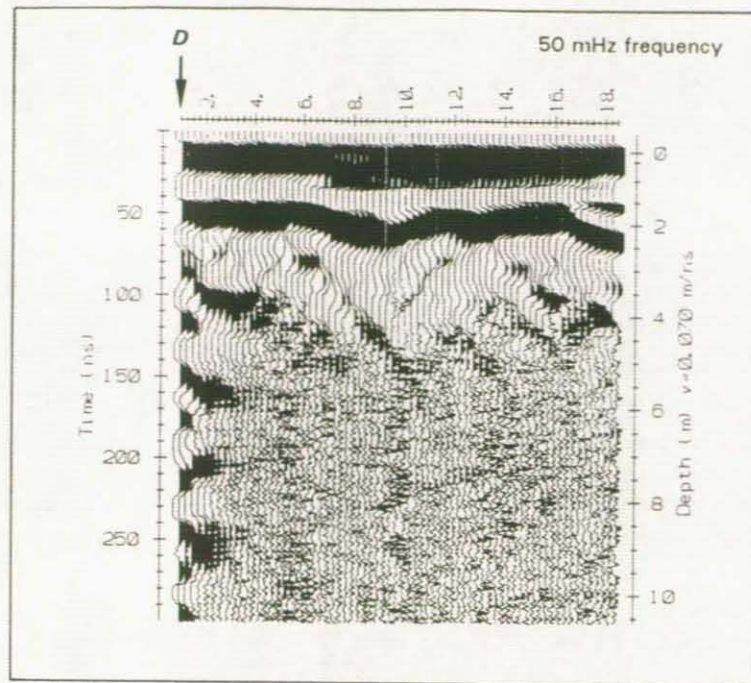


Figure 24 *gpr*. Test Site 2.5. GPR profile for line Fence.

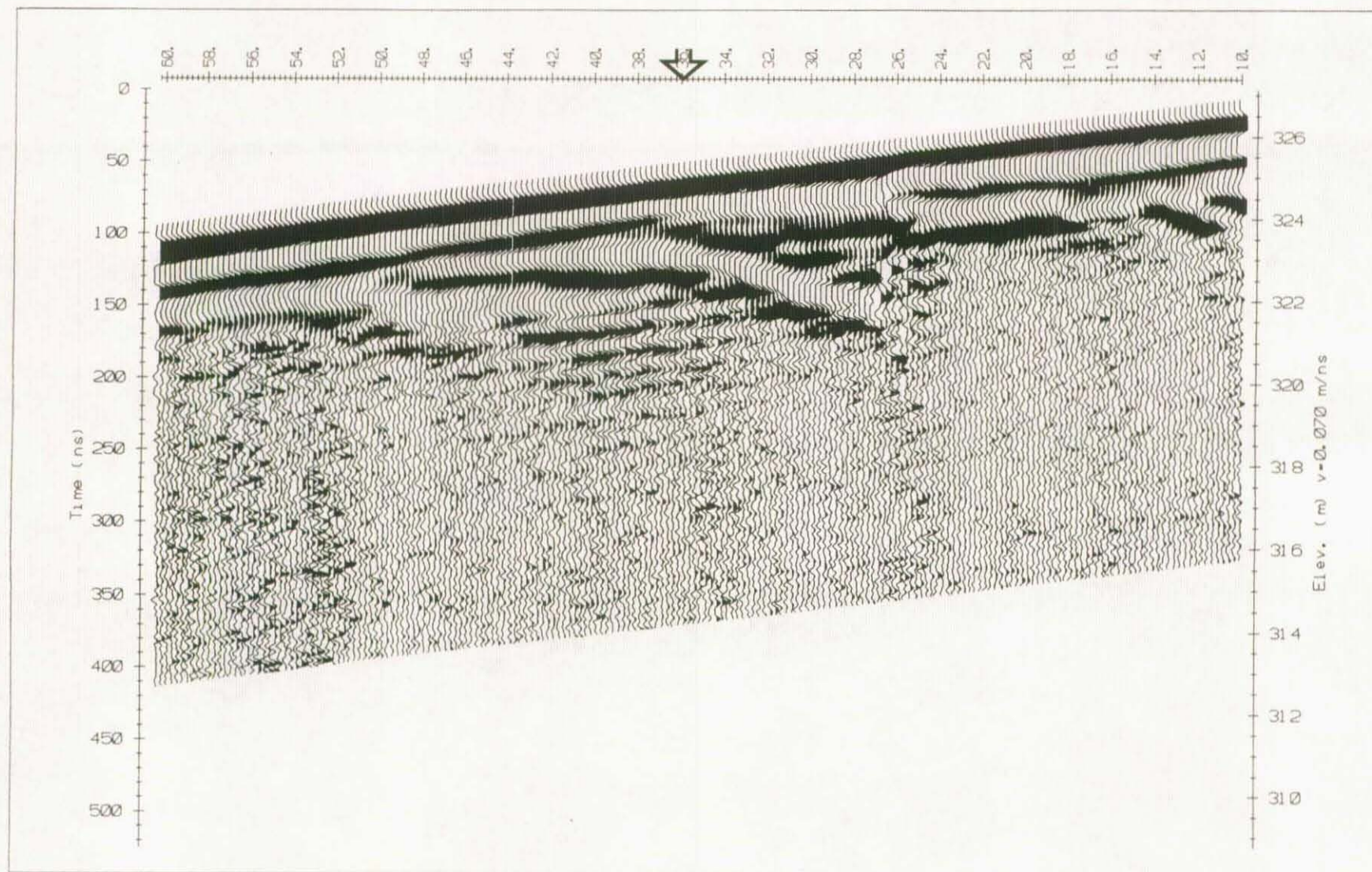


Figure 25 *gpr*. Test Site 3.1. GPR profile for line 80W. 50 MHz antennae.

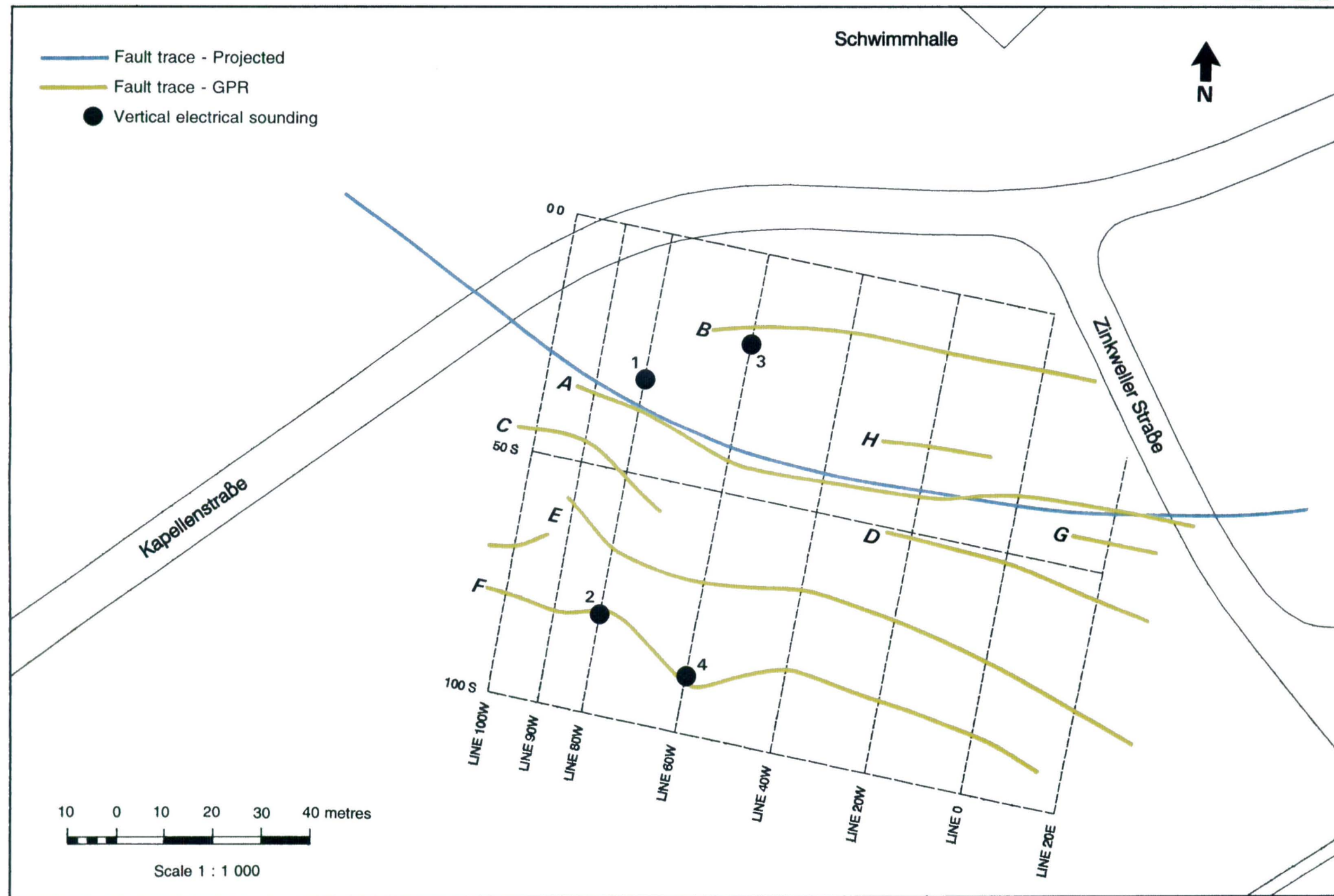


Figure 22. Test Site 3.1. Geophysical grid and interpretation.

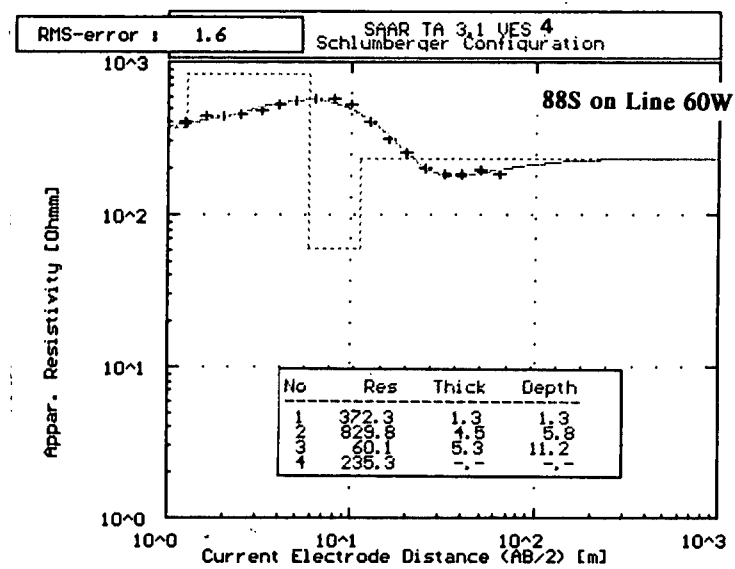
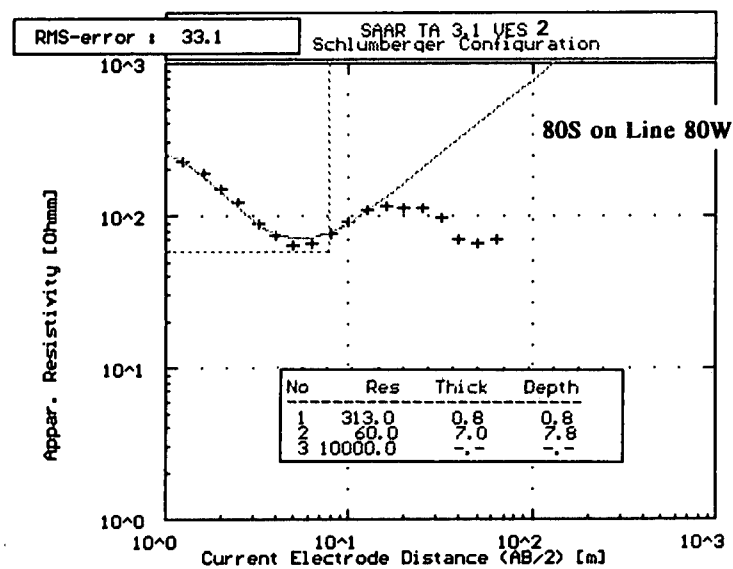
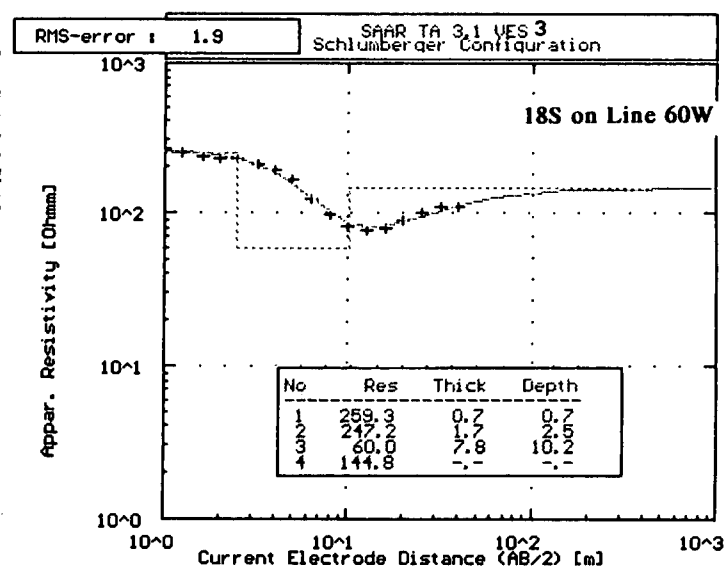
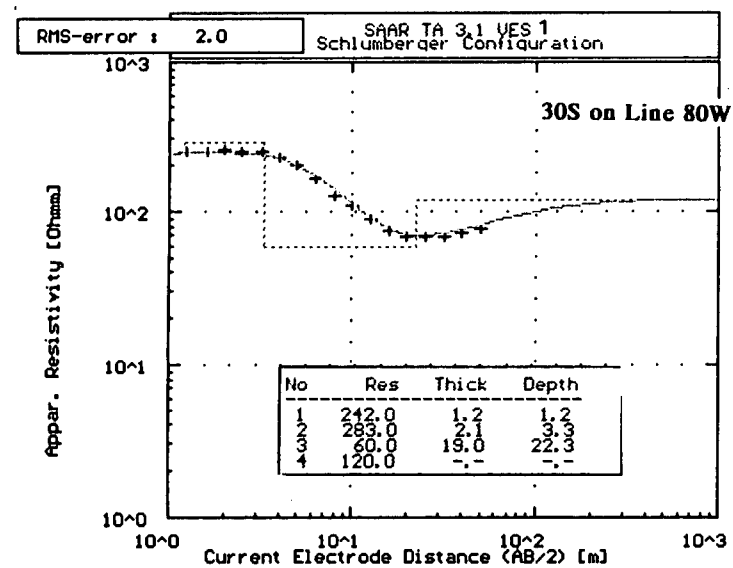


Figure 14 res.

Test Site 3.1. Interpretation of VES 1, 2, 3, and 4.

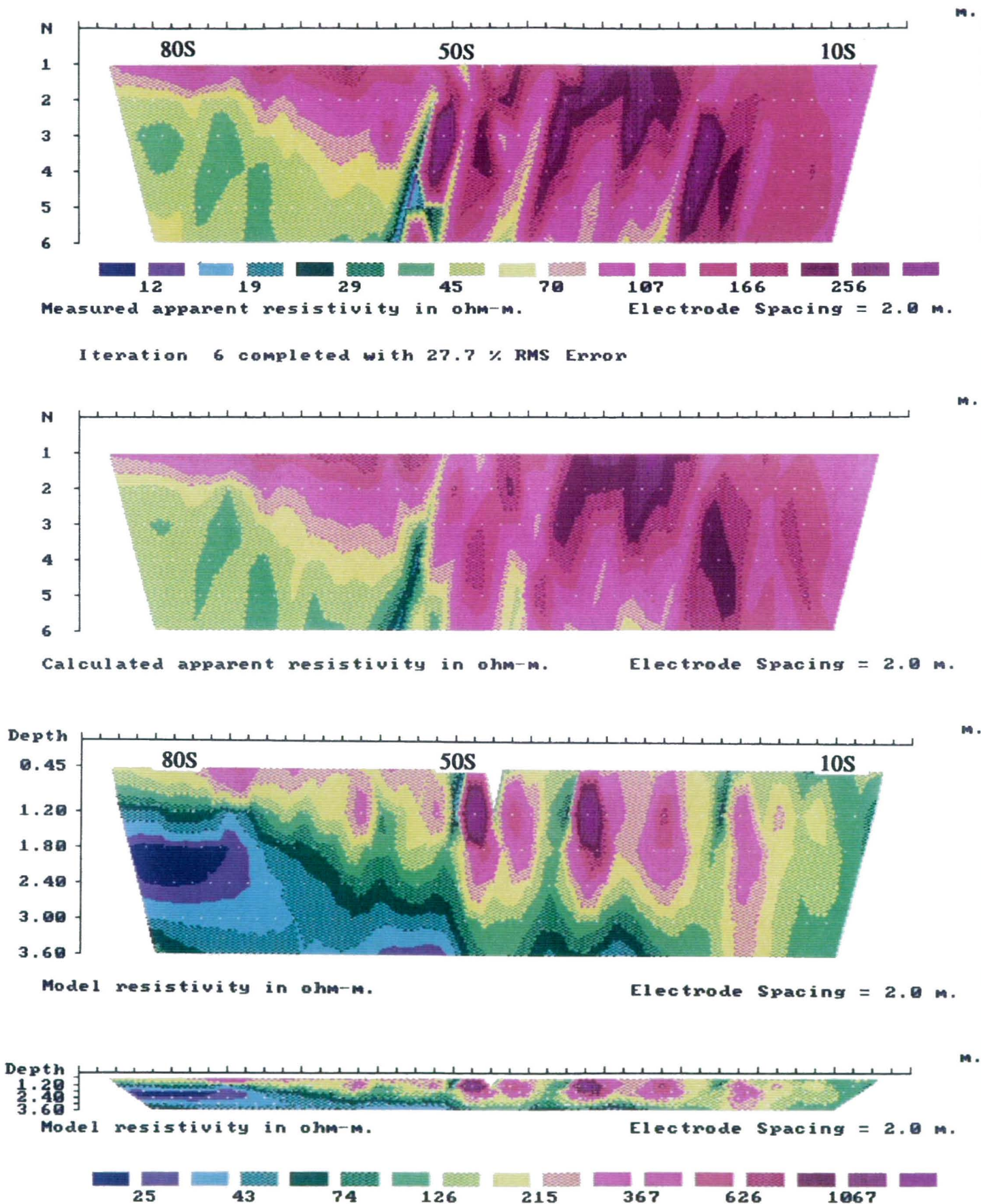


Figure 13 res.

Test Site 3.1. Line 80W. Dipole-dipole resistivity data.

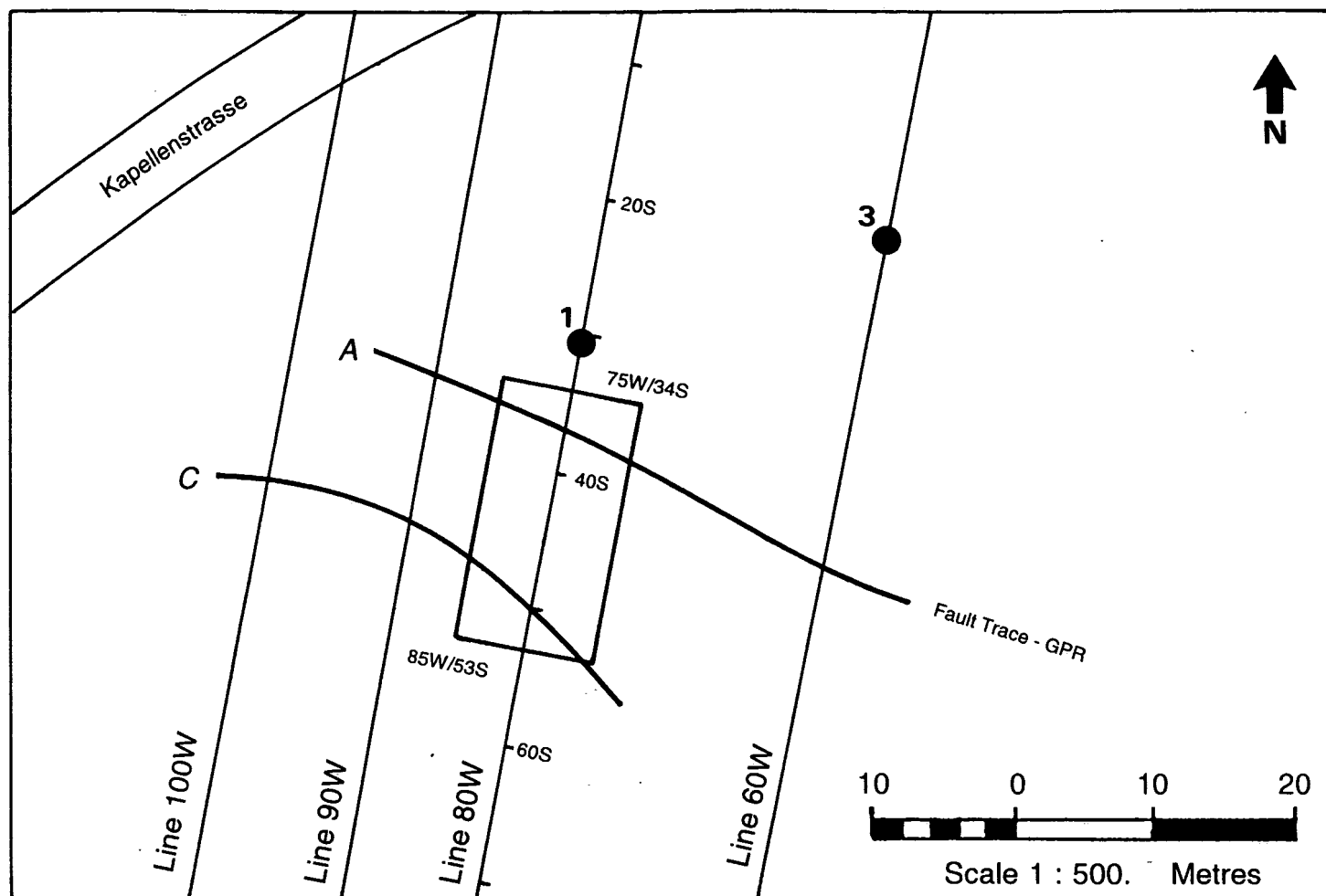


Figure 11 rsc. Test Site 3.1. Plan (partial) of site showing location of RESCAN survey grid.

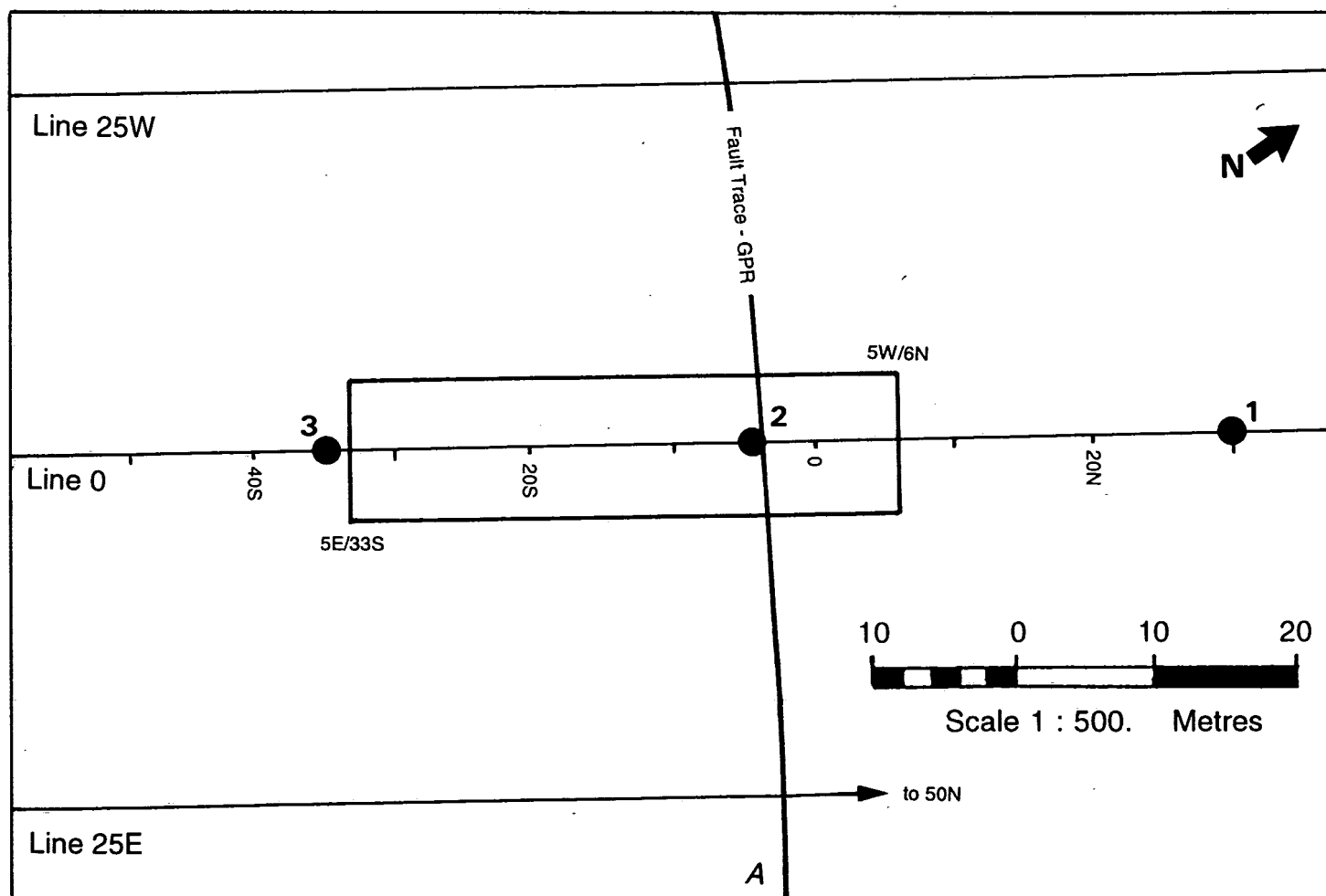


Figure 13 rsc. Test Site 3.2. Plan (partial) of site showing location of RESCAN survey grid.

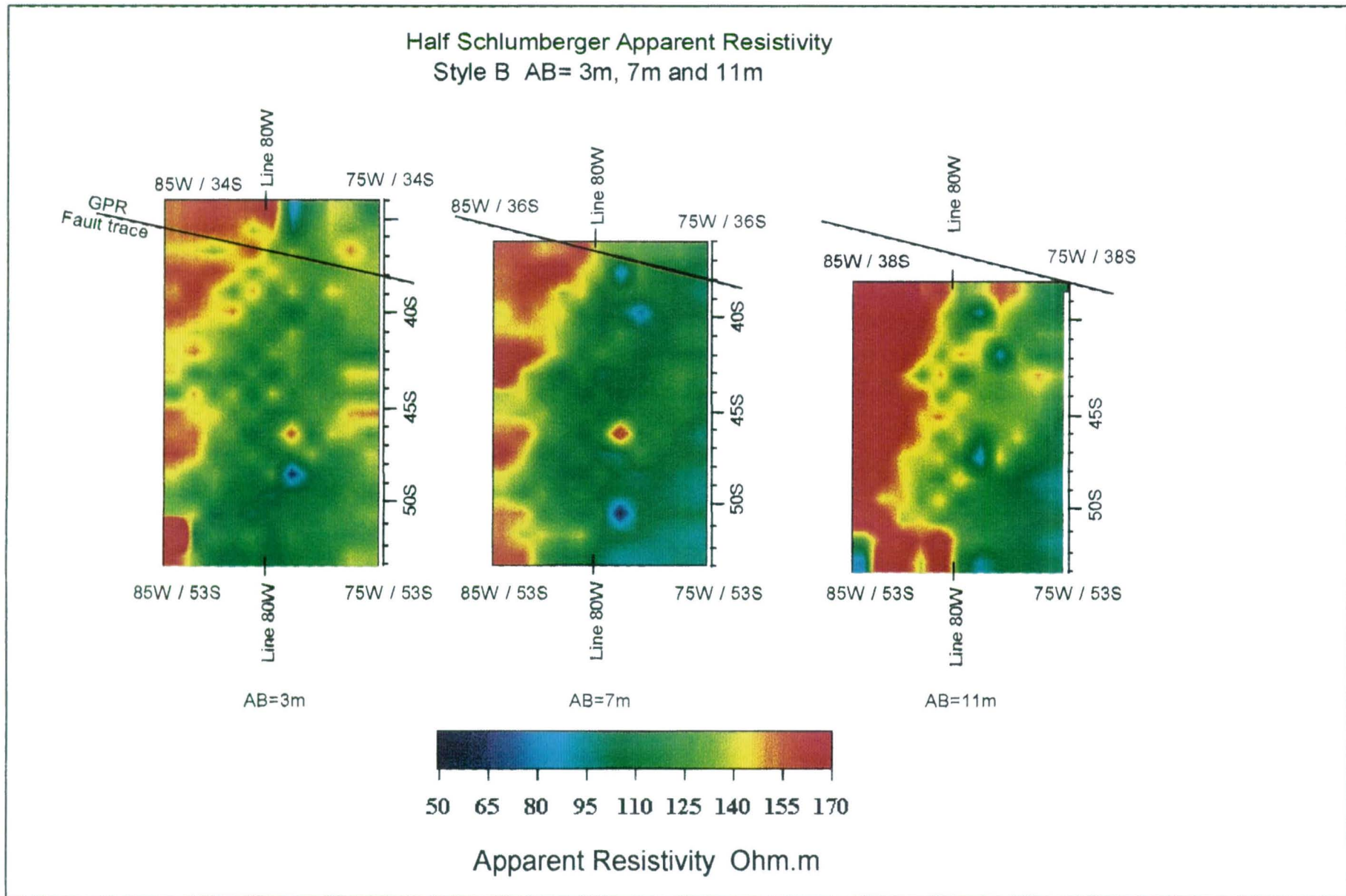
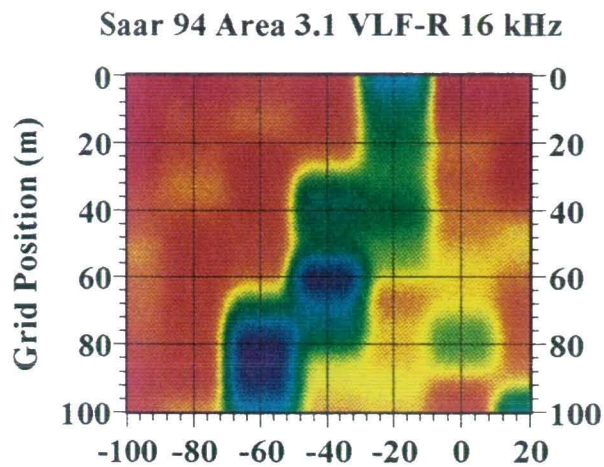


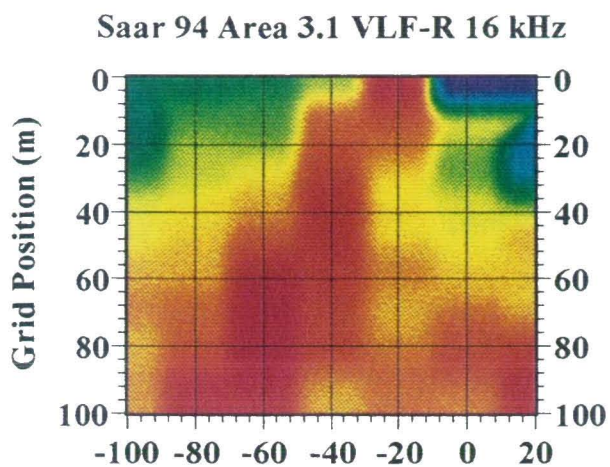
Figure 12 *rsc.* Test Site 3.1. Apparent resistivity data, showing projected position of the fault.

Line orientation N10E, 16kHz E-field at N123E



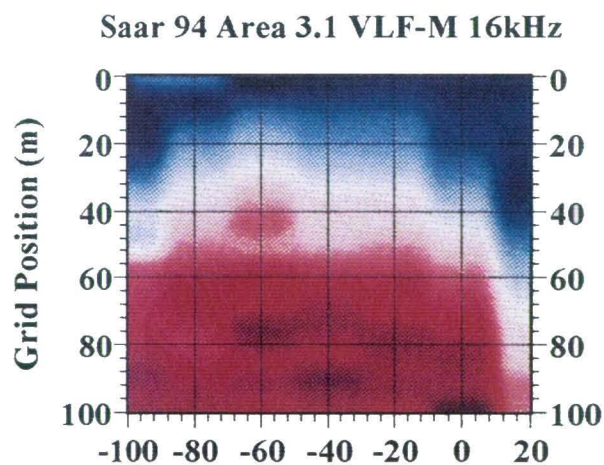
50 150 250 350

Apparent Resistivity (ohm.m)



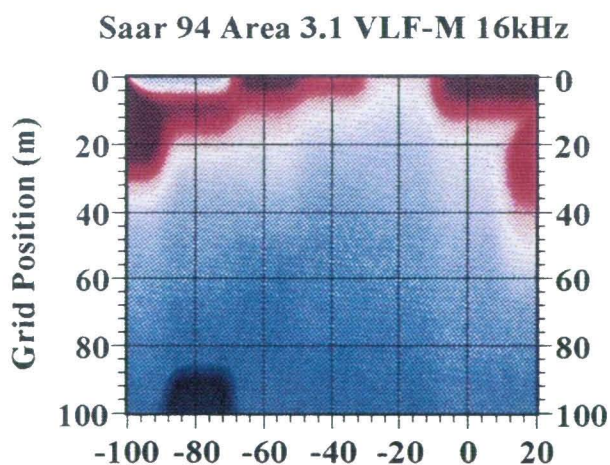
50 60 70 80

Phase (degrees)



-50 -25 0

Real (Z/H) %



0 25

Imag (Z/H) %

Figure 24 *vlf*. Test Site 3.1. VLF-R and VLF-Z field data for 16 kHz transmitter.

Line orientation N10E, 24kHz E-field at N85E

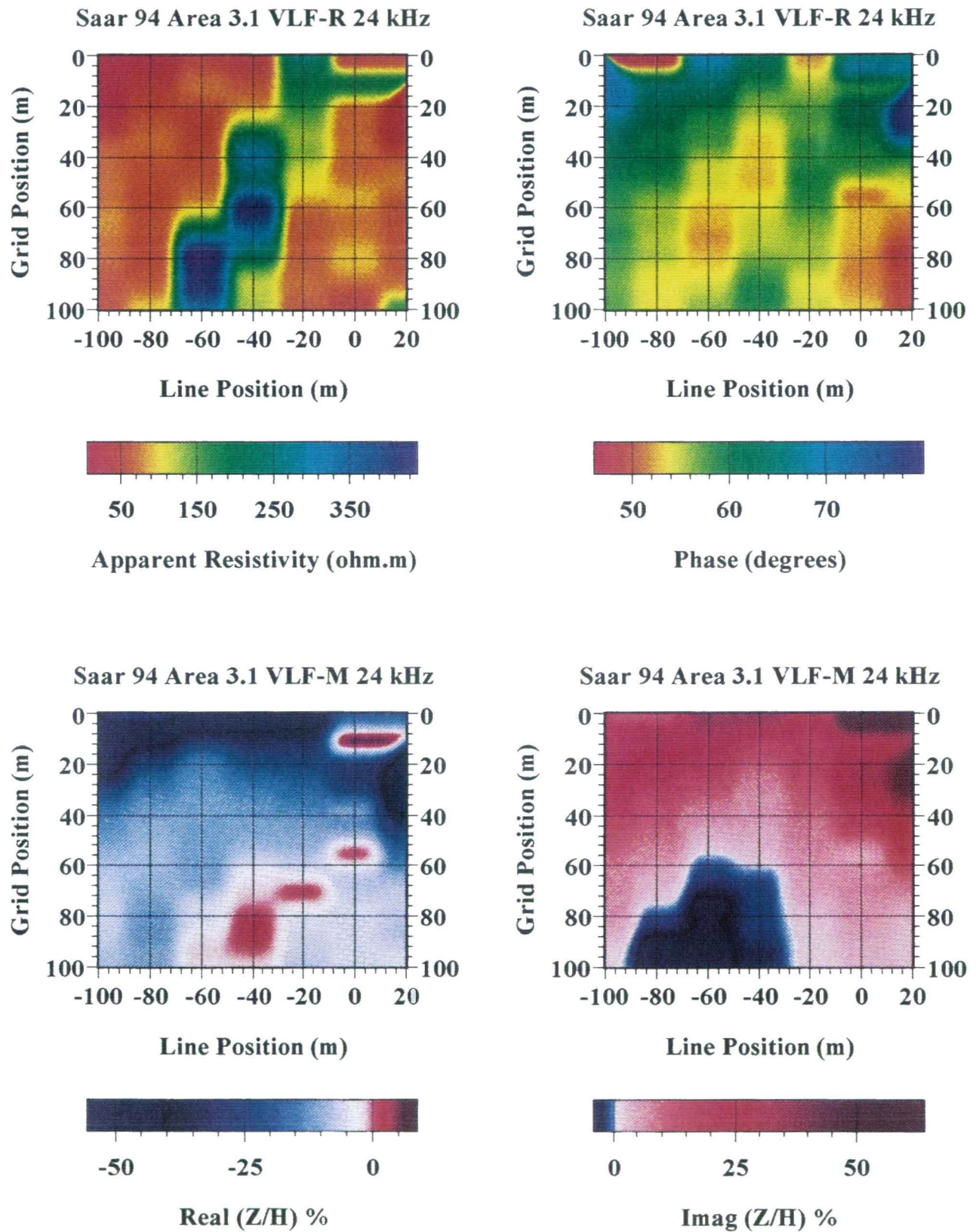


Figure 25 vlf. Test Site 3.1. VLF-R and VLF-Z field data for 24 kHz transmitter.

**Line orientation N10E, 24kHz E-field at N85E
16 kHz E-field at N123E**

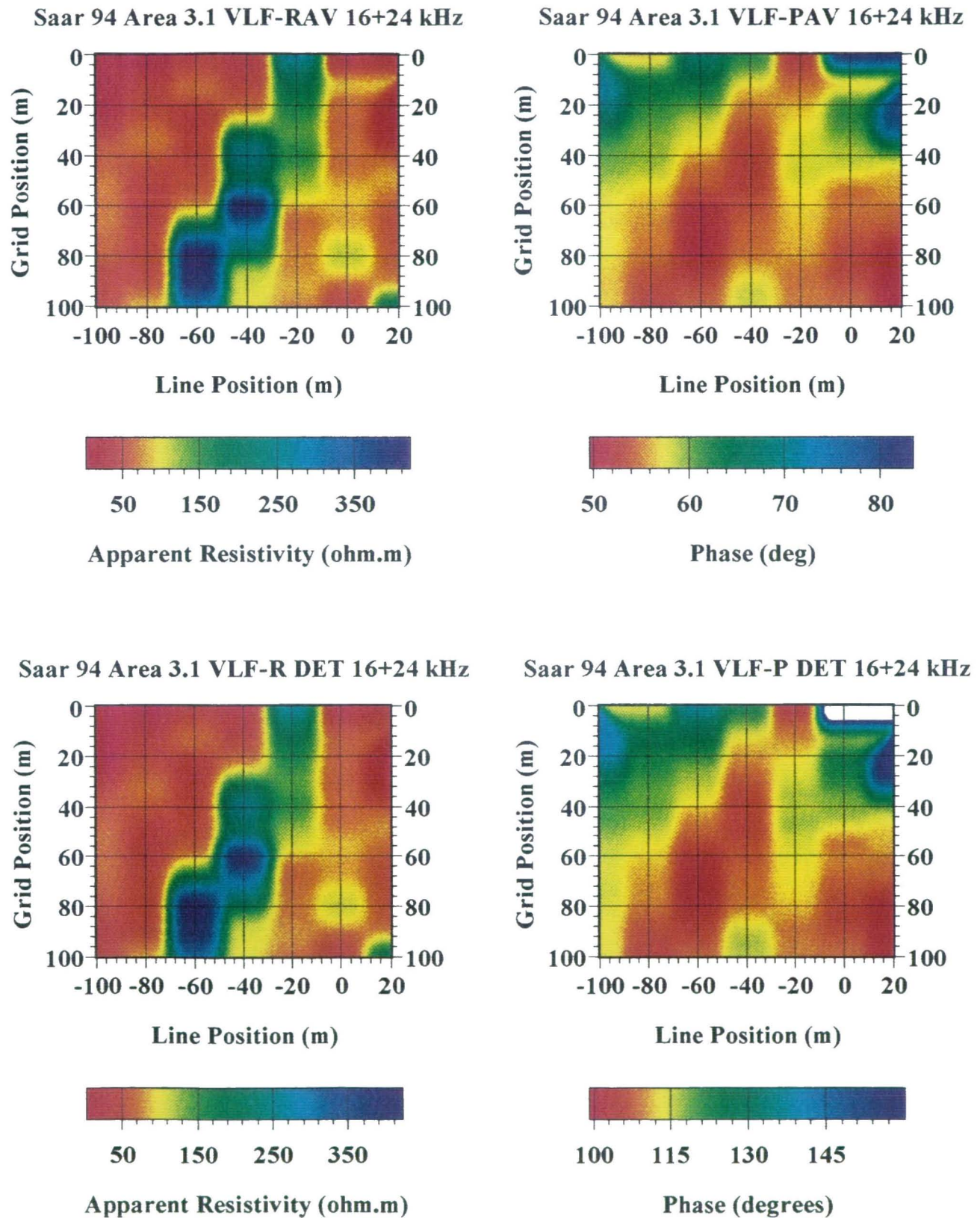


Figure 26 *vlf*. Test Site 3.1. Invariant mapping: 16 kHz and 24 kHz transmitters.

Line orientation N10E, 16 kHz E-field at N123E
24kHz E-field at N85E

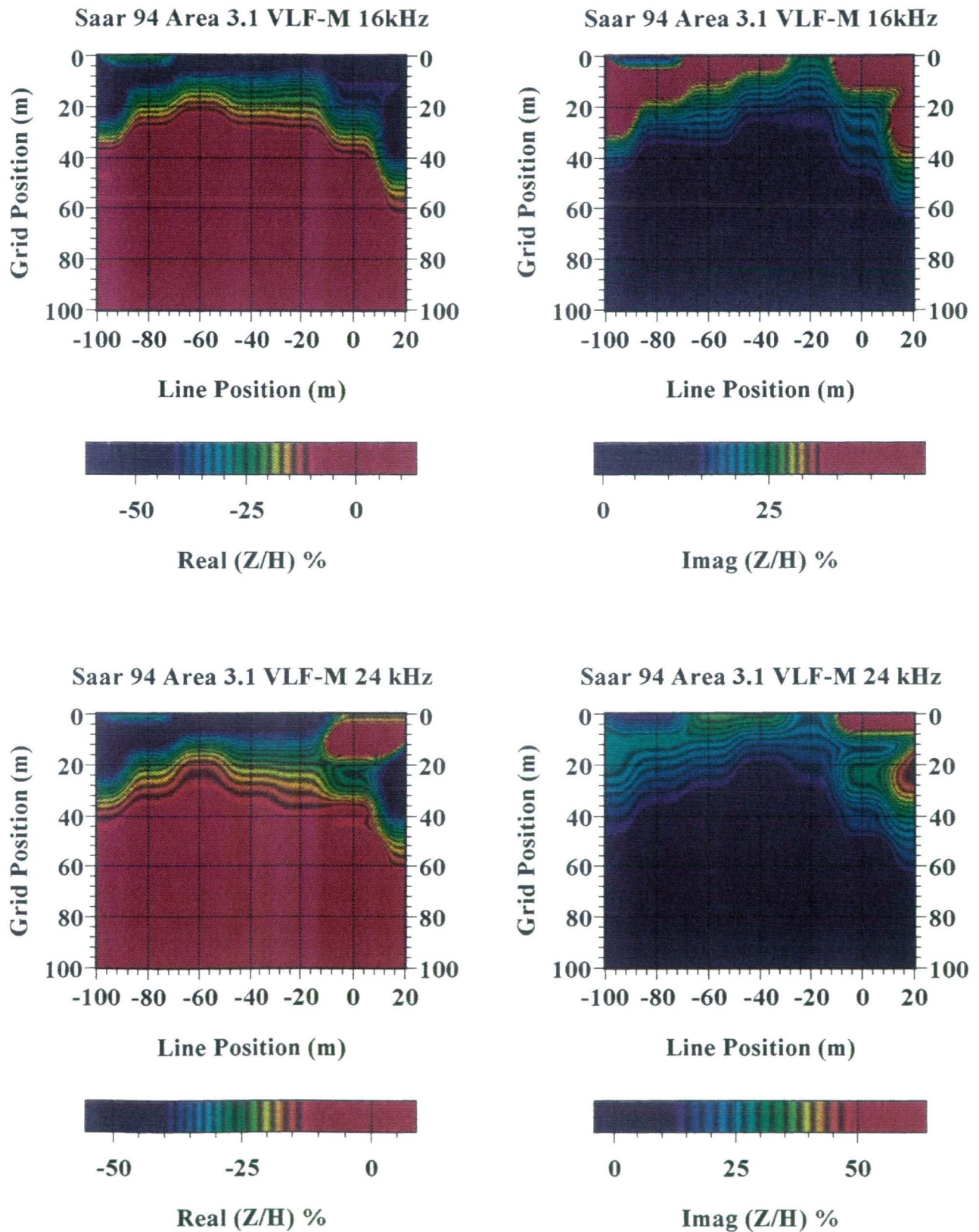


Figure 27 *vlf*. Test Site 3.1. VLF-Z field data using banded contour scale.

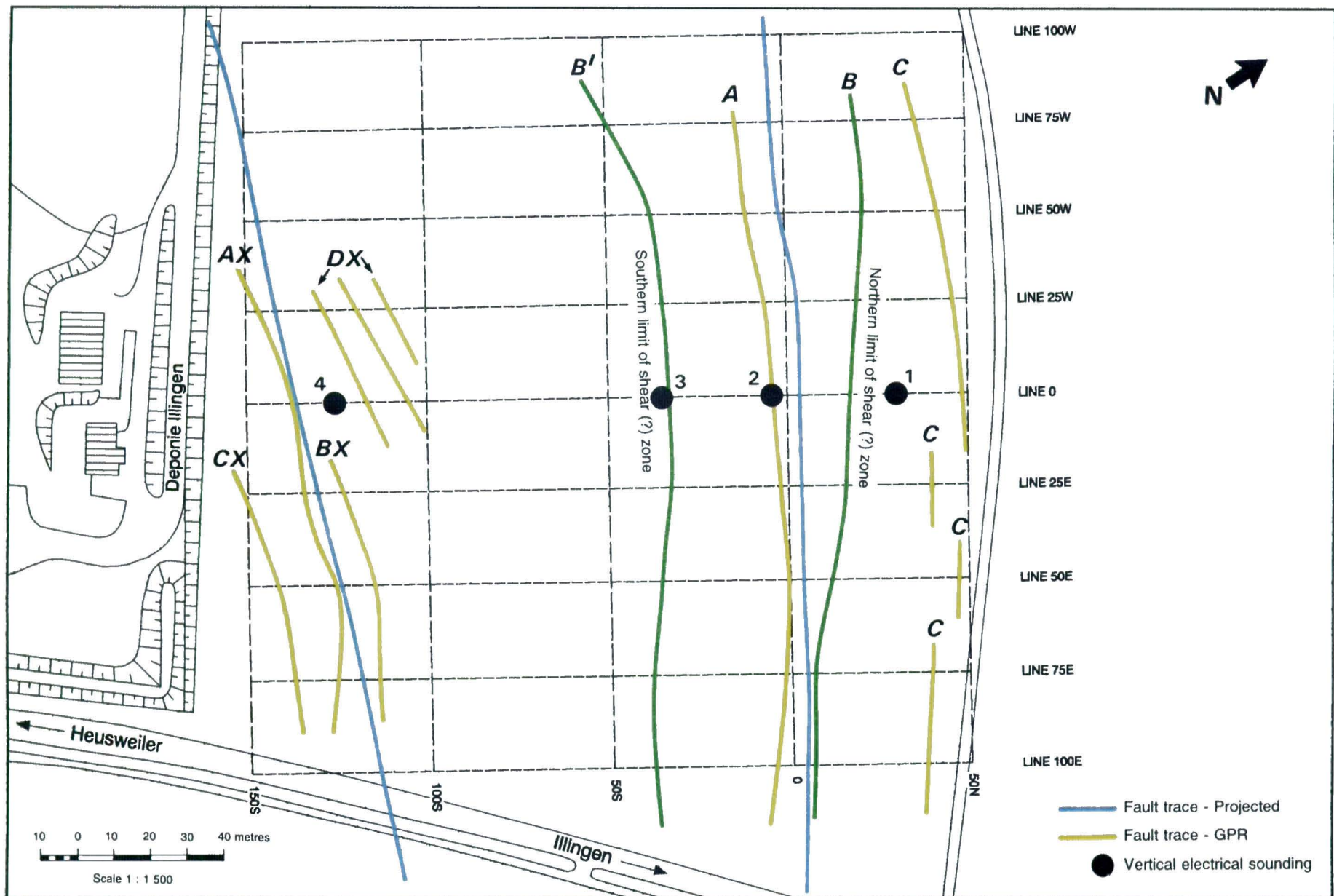


Figure 23. Test Sites 3.2 and 3.2 (Ext). Geophysical grid and interpretation.

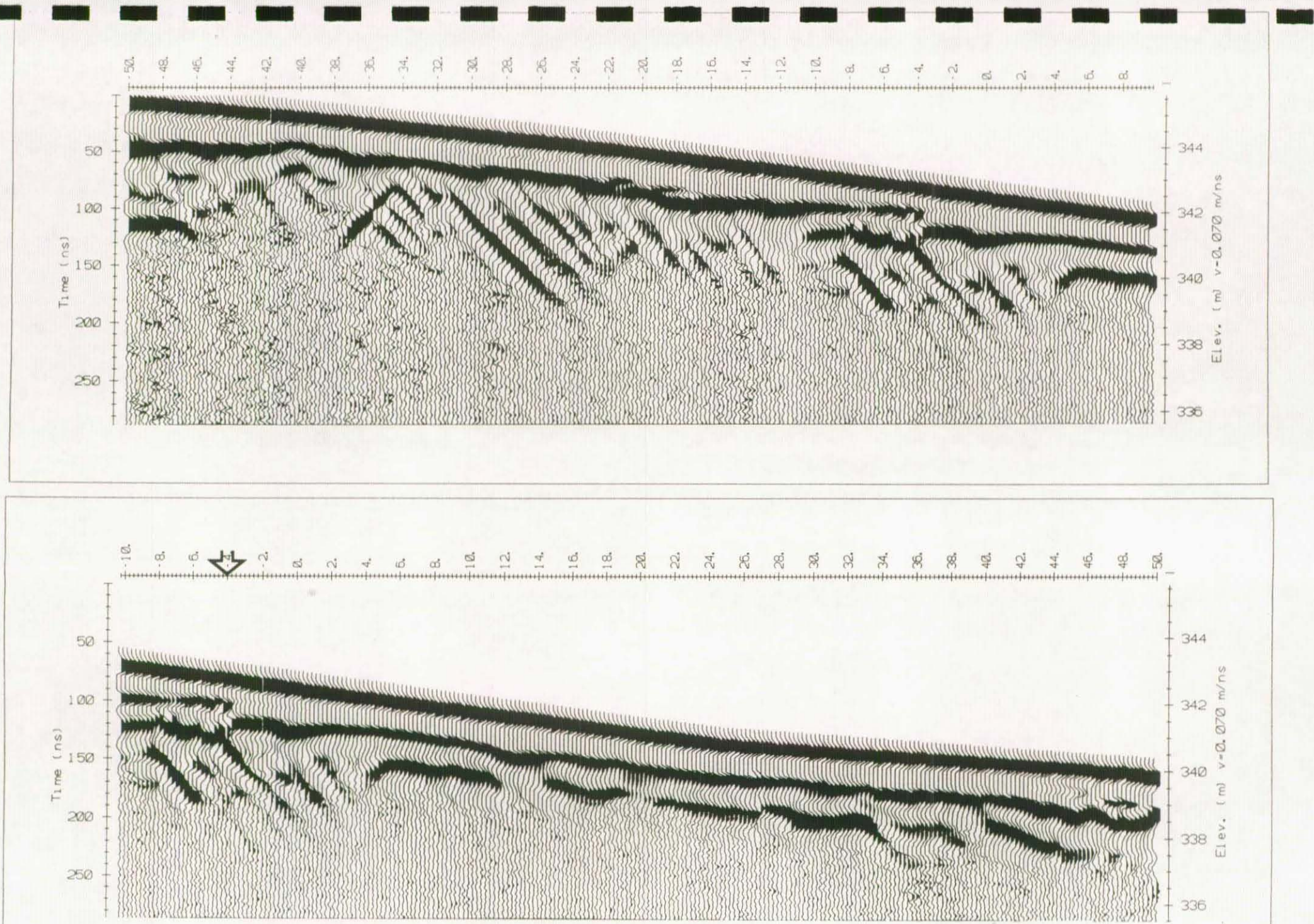


Figure 26 gpr. Test Site 3.2. GPR profile for line 100E. 50 MHz antennae.

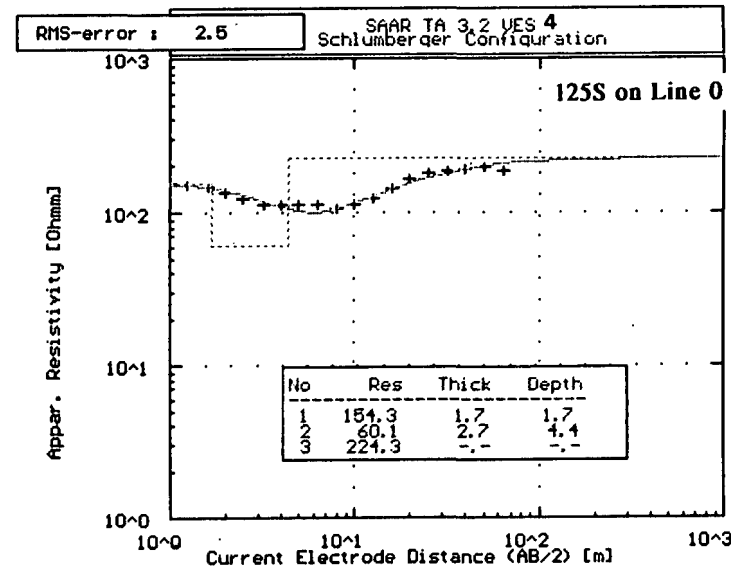
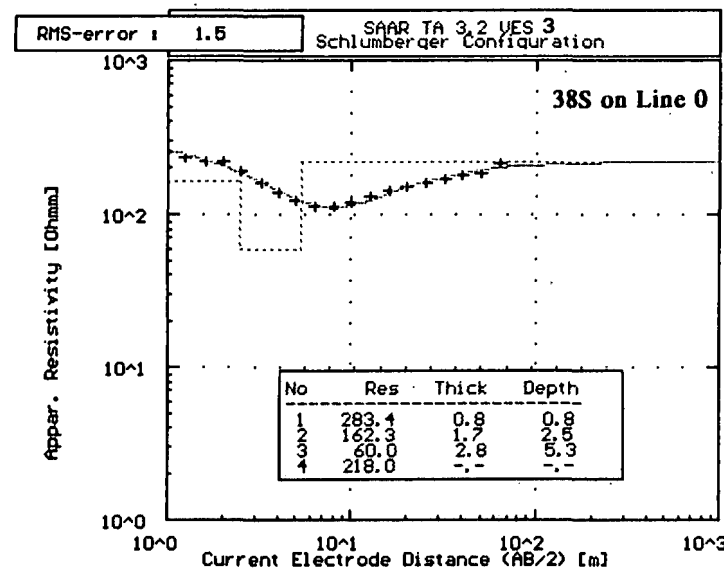
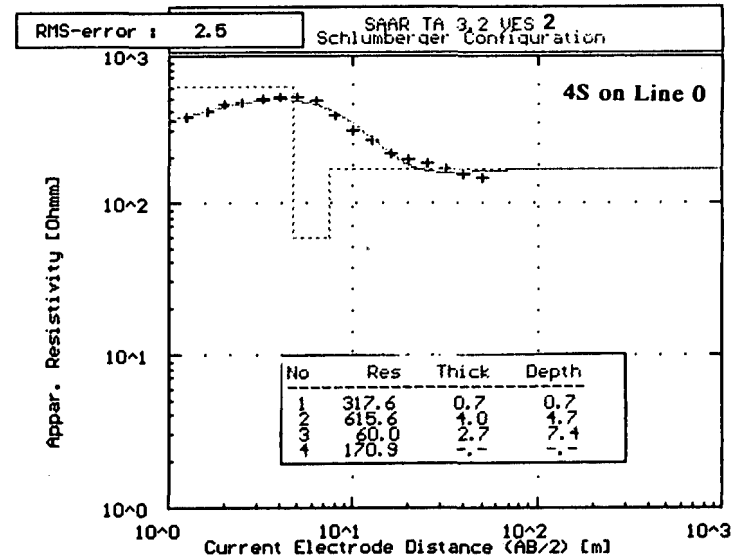
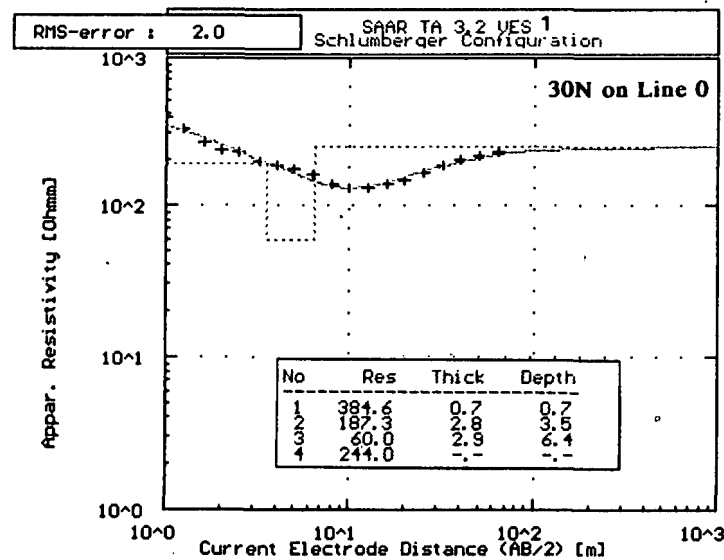
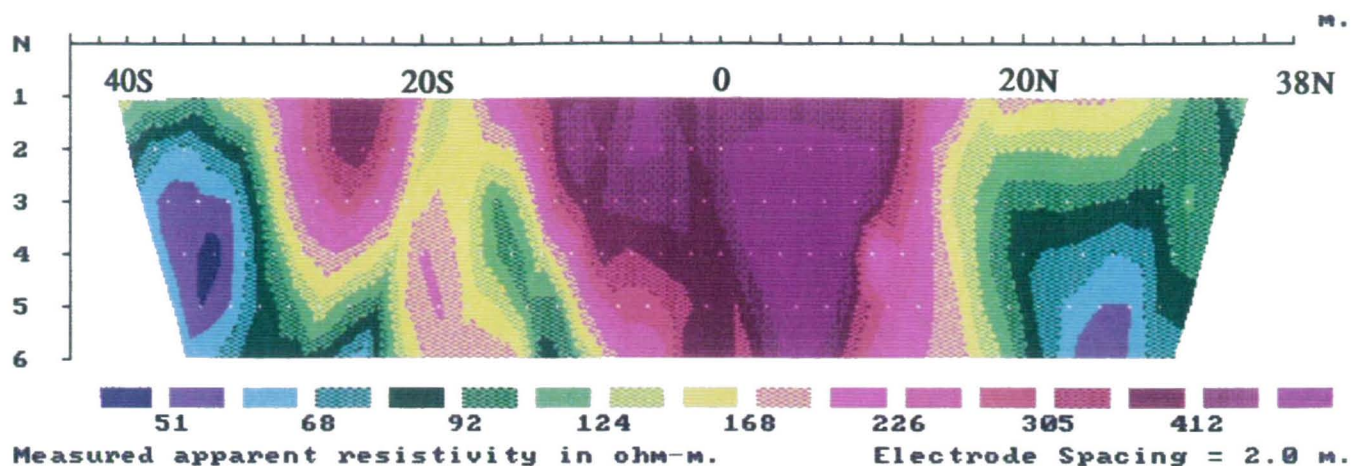


Figure 16 res.

Test Site 3.2. Interpretation of VES 1, 2, 3, and 4.



Iteration 6 completed with 6.1 % RMS Error

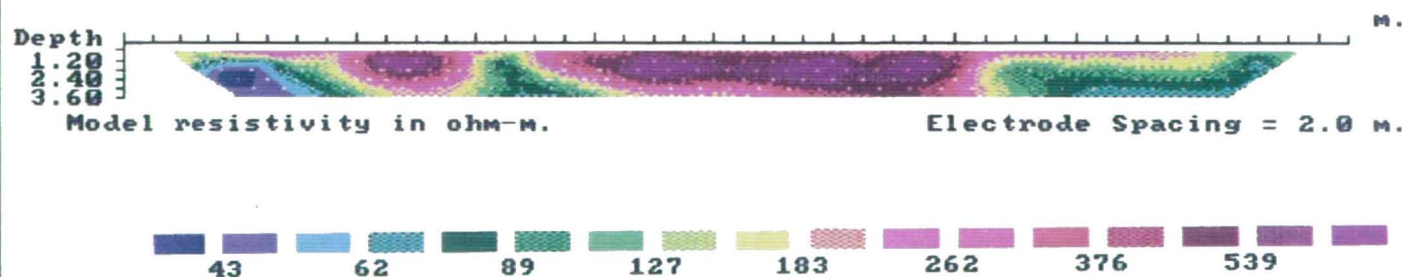
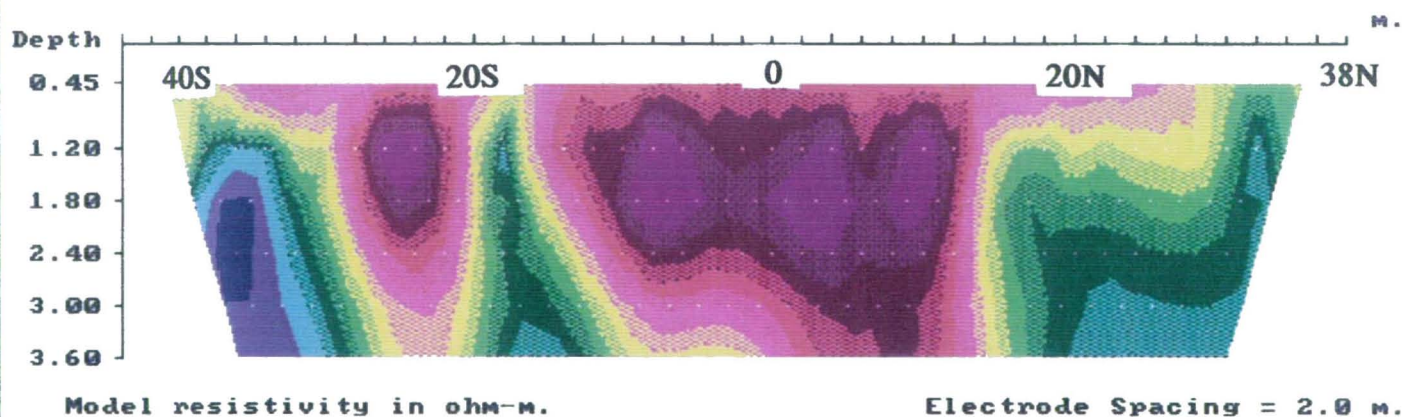
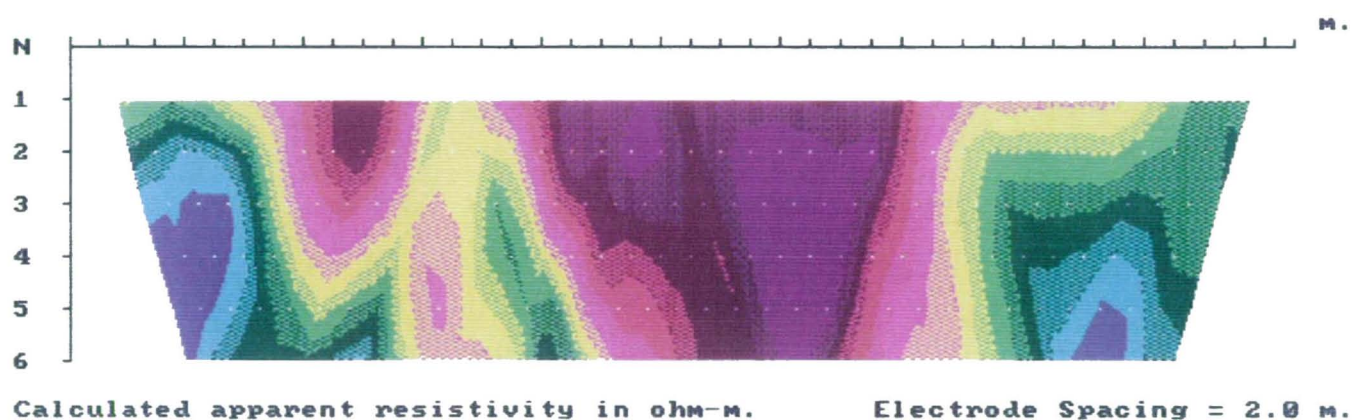


Figure 15 res.

Test Site 3.2. Line 0. Dipole-dipole resistivity data.

Half - Schlumberger Apparent Resistivity Style B AB=3m

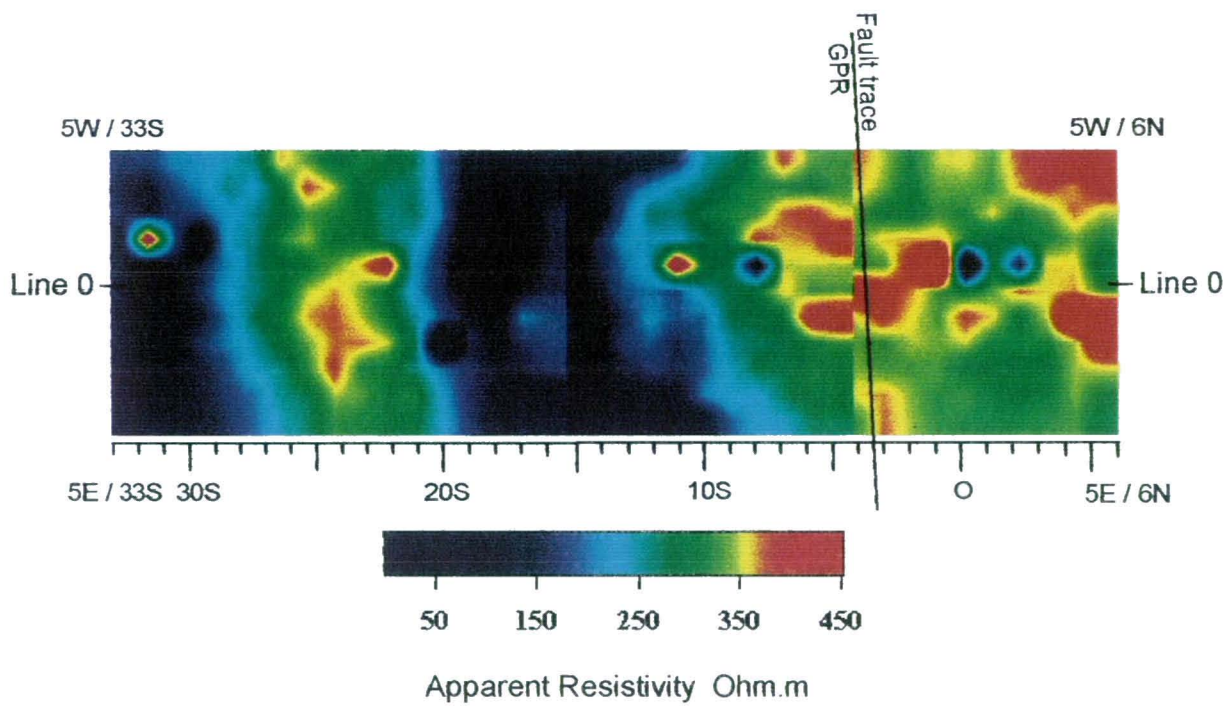
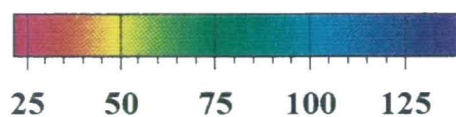
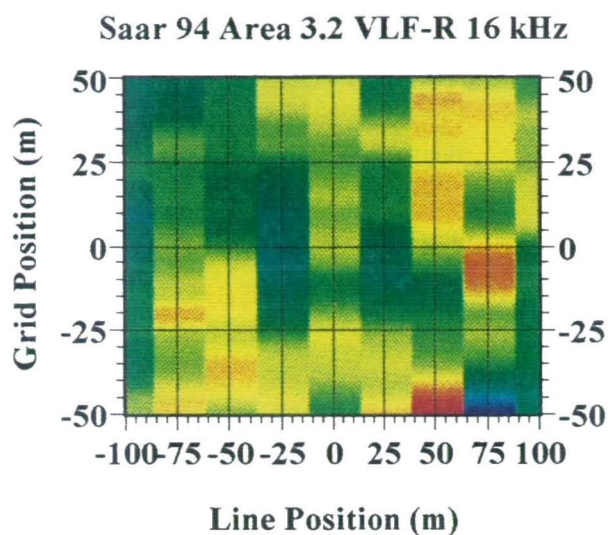
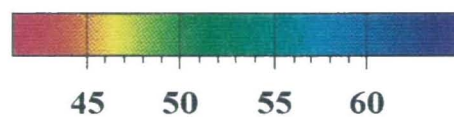
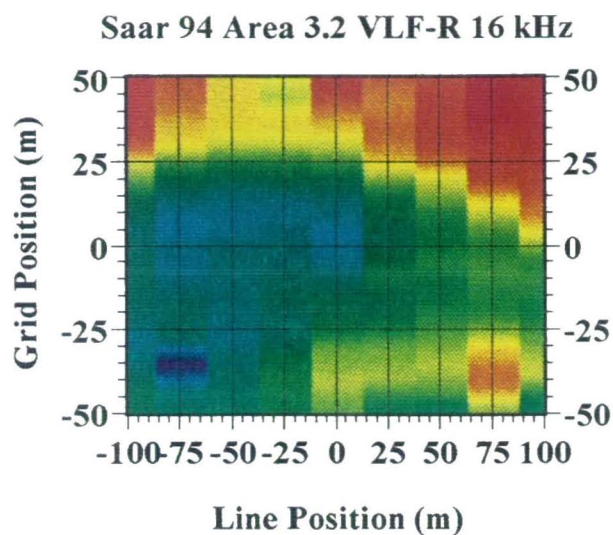


Figure 14 *rsc*. Test Site 3.2. RESCAN apparent resistivity maps for three overlapping sections.

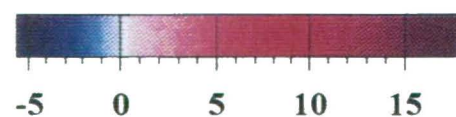
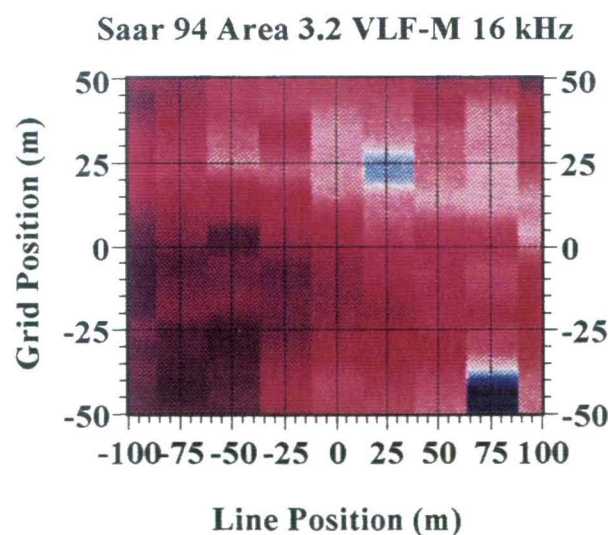
Line orientation N30E, 16kHz E-field at N123E



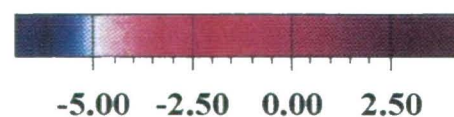
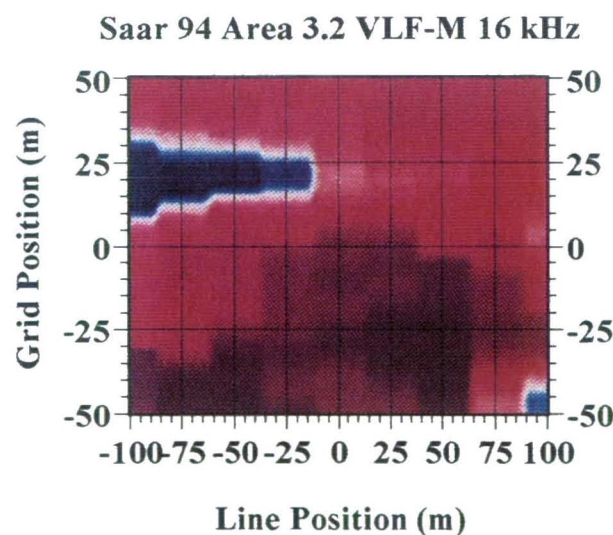
Apparent Resistivity (ohm.m)



Phase (degrees)



Real (Z/H) %



Imag (Z/H) %

Figure 28 vlf. Test Site 3.2. VLF-R and VLF-Z field data for 16 kHz transmitter.

Line orientation N30E, 24kHz E-field at N85E

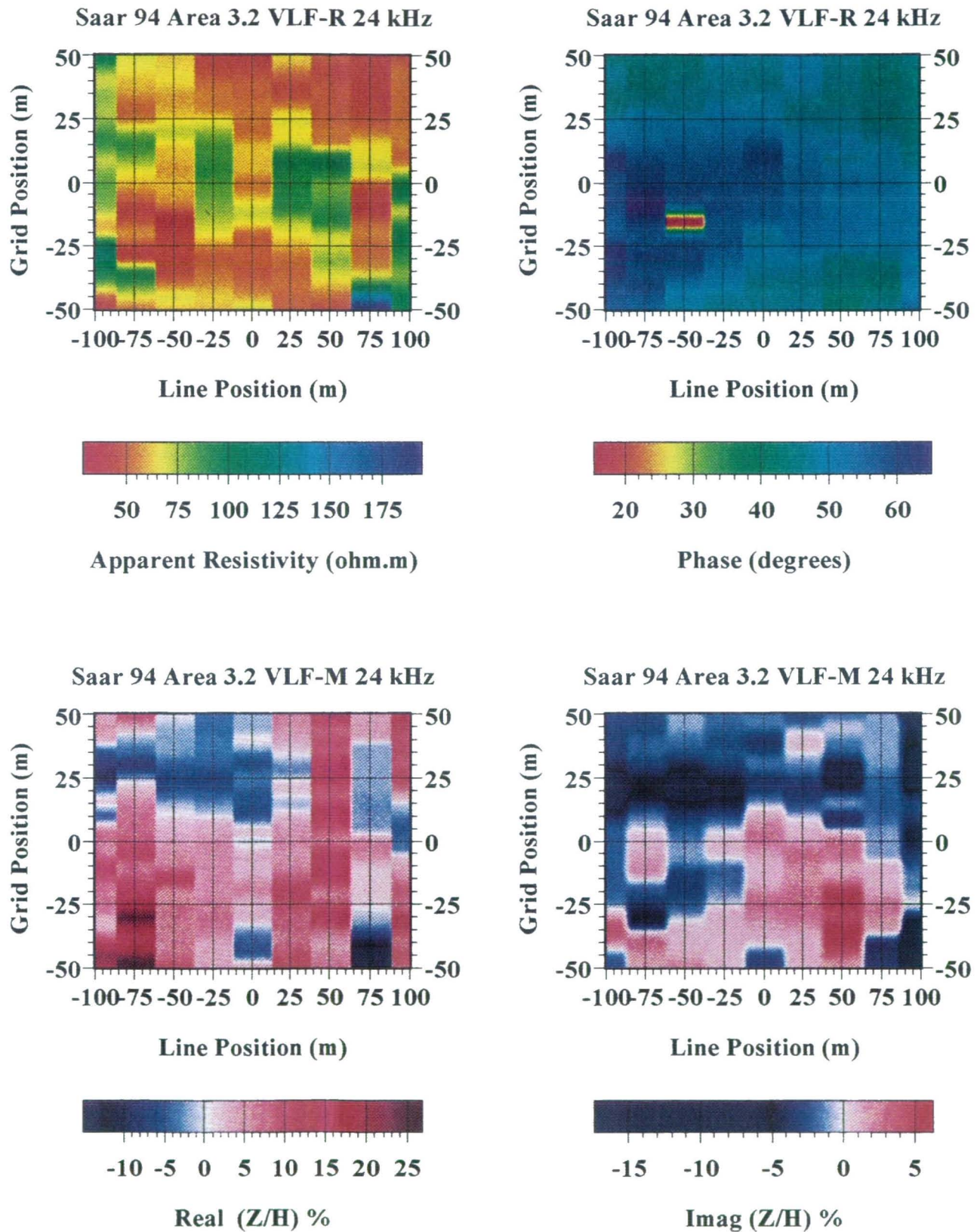


Figure 29 *vlf*. Test Site 3.2. VLF-R and VLF-Z field data for 24 kHz transmitter.

Line orientation N30E, 16 kHz E-field at N123E
24 kHz E-field at N85E

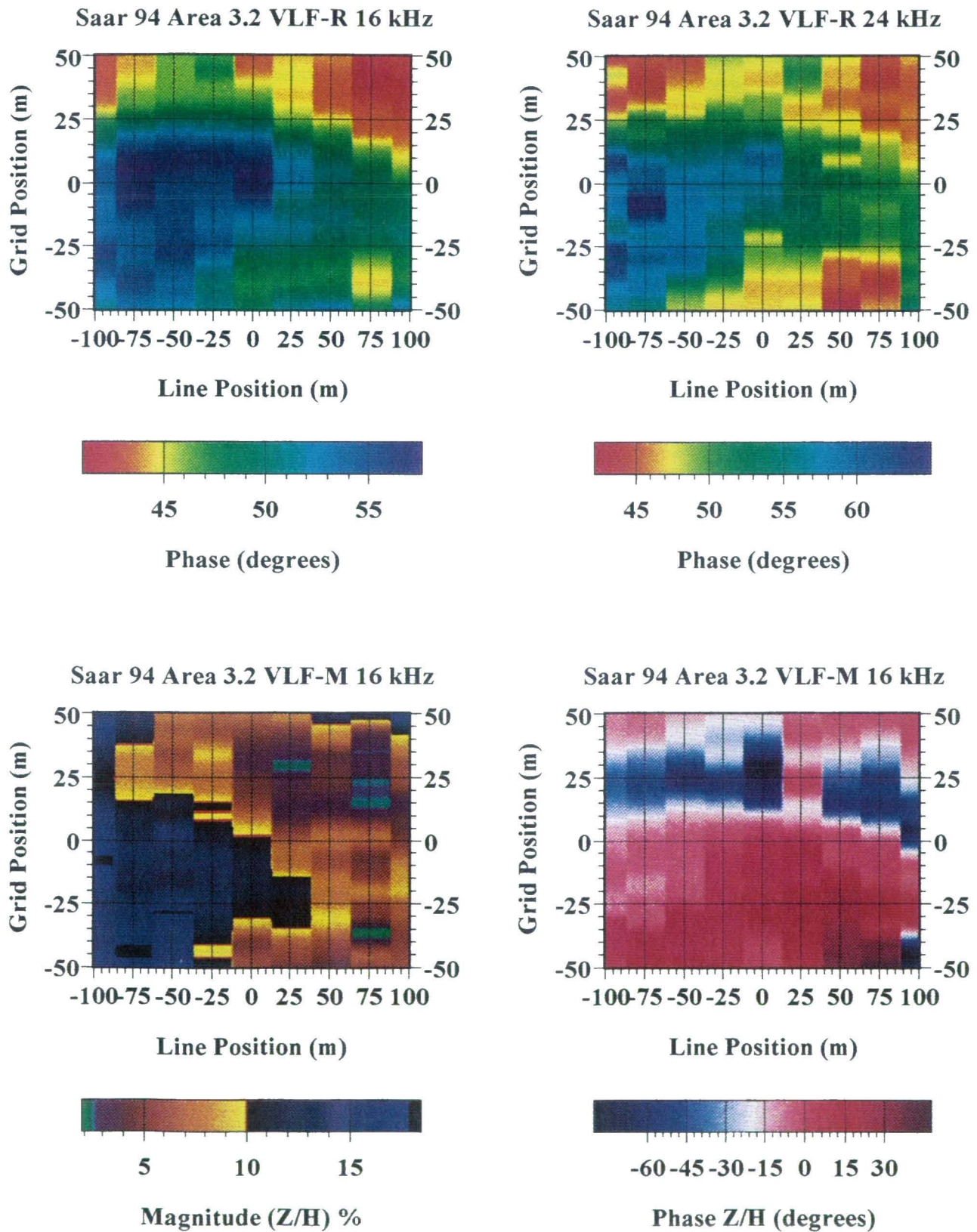


Figure 30 *vlf*. Test Site 3.2. VLF-R (phase) for 16 and 24 kHz transmitters and VLF-Z (converted magnitude and phase) for 16 kHz transmitter.

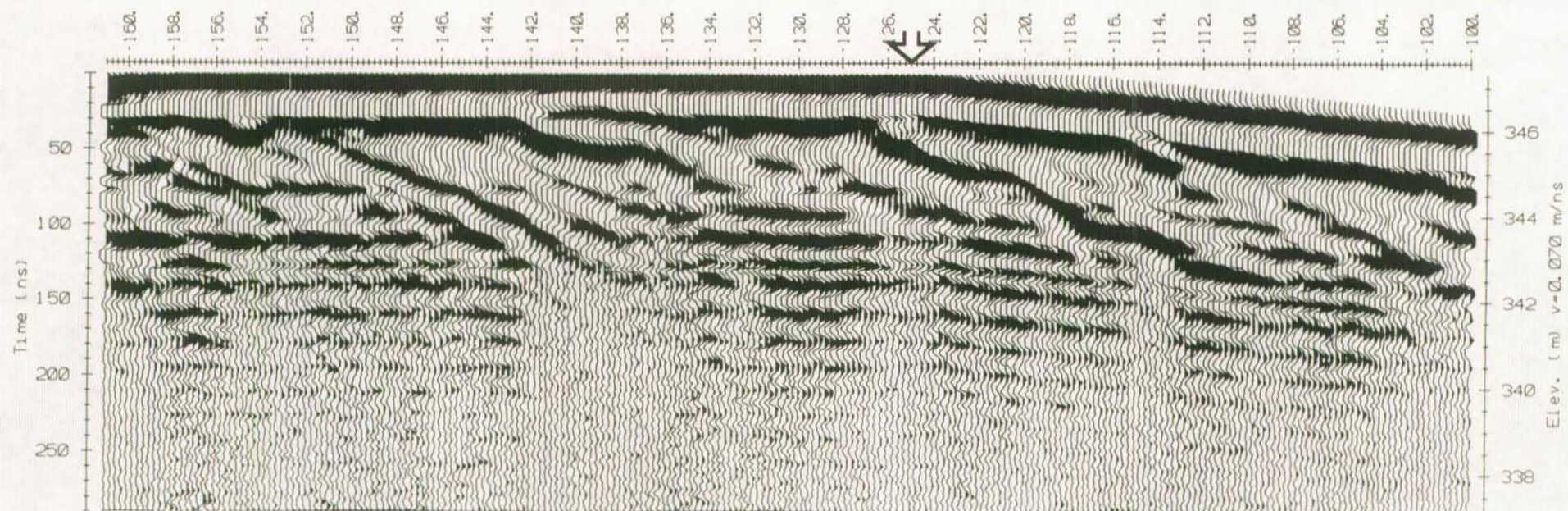


Figure 27 *gpr*. Test Site 3.2 (Ext). GPR profile for line 50EX. 50 MHz antennae.

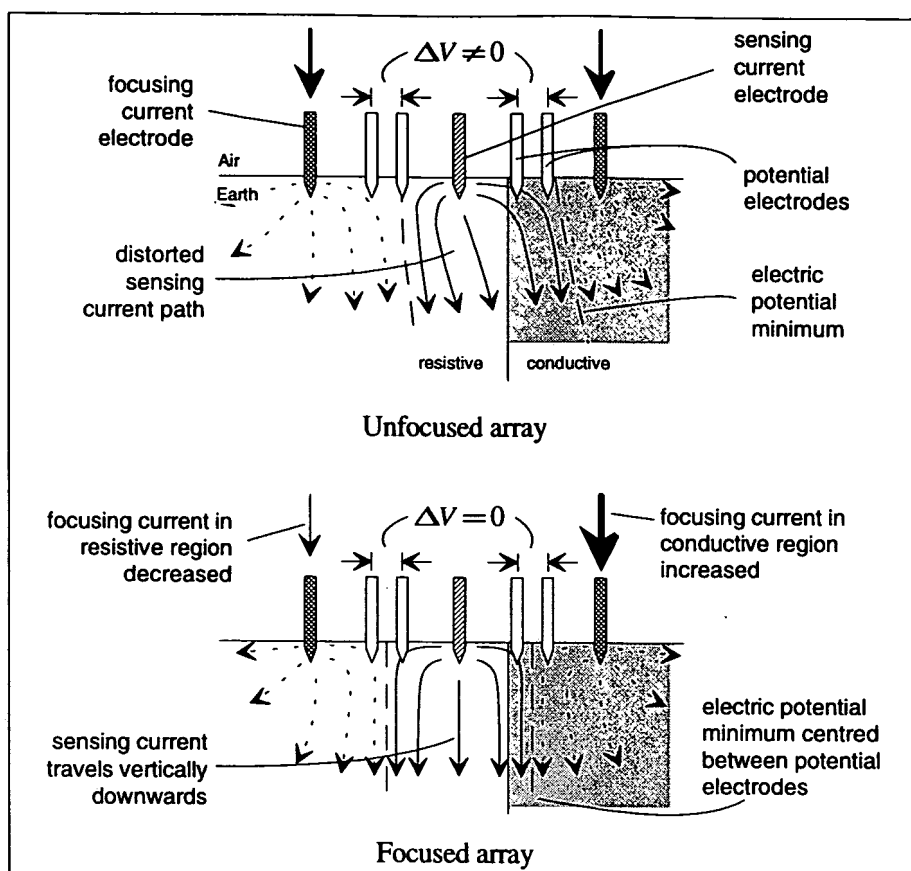


Figure 15 rsc. Focussed currents over a conductive/resistive boundary (schematic).

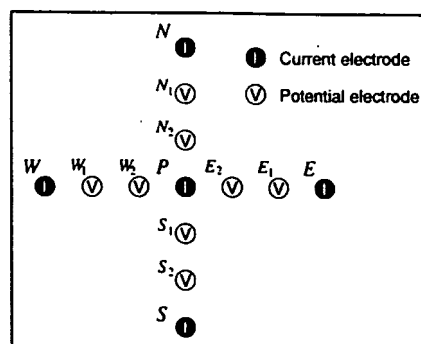


Figure 16 rsc. Electrode configuration (schematic) for a 'double laterolog' focussed array proposed by Jackson (1981).

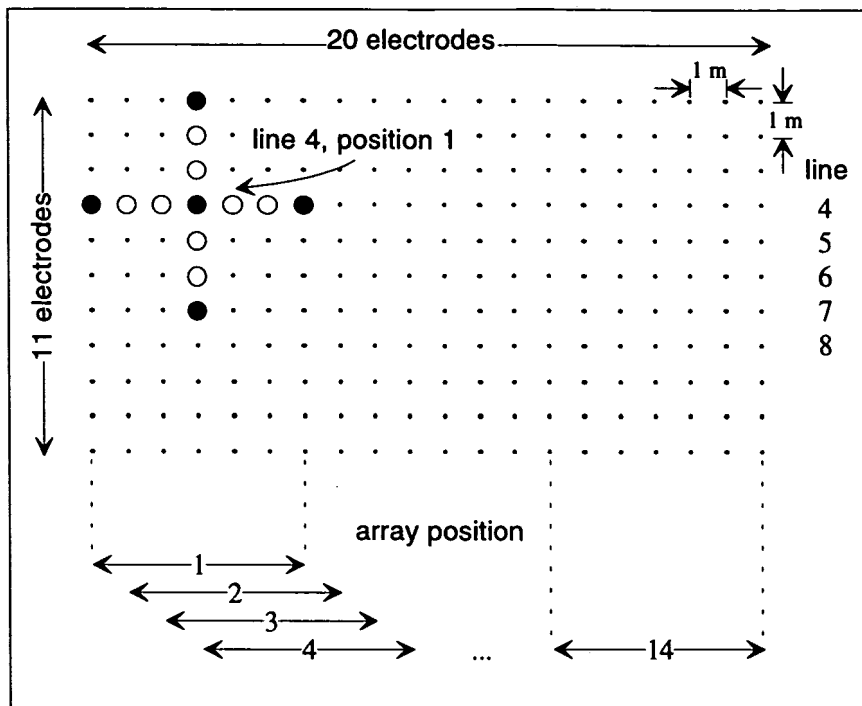


Figure 17 *rsc.* RESCAN electrode grid and focussed array positions.

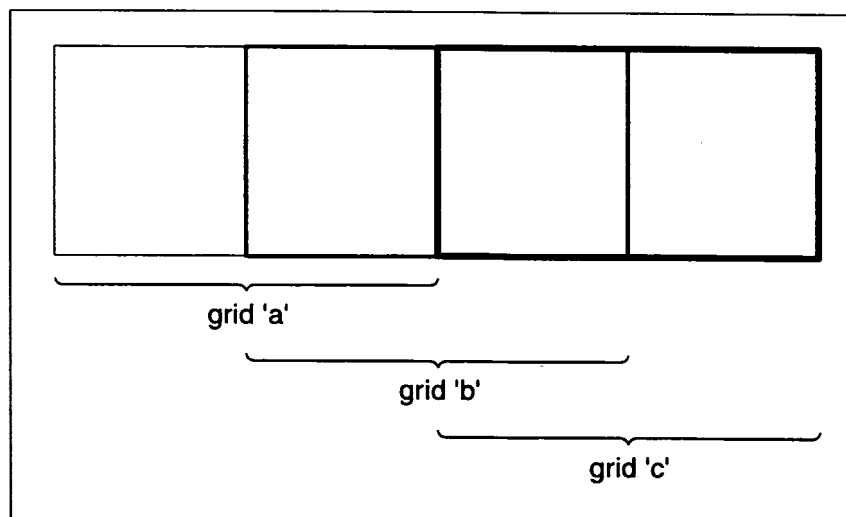


Figure 18 *rsc.* Adjacent grids.

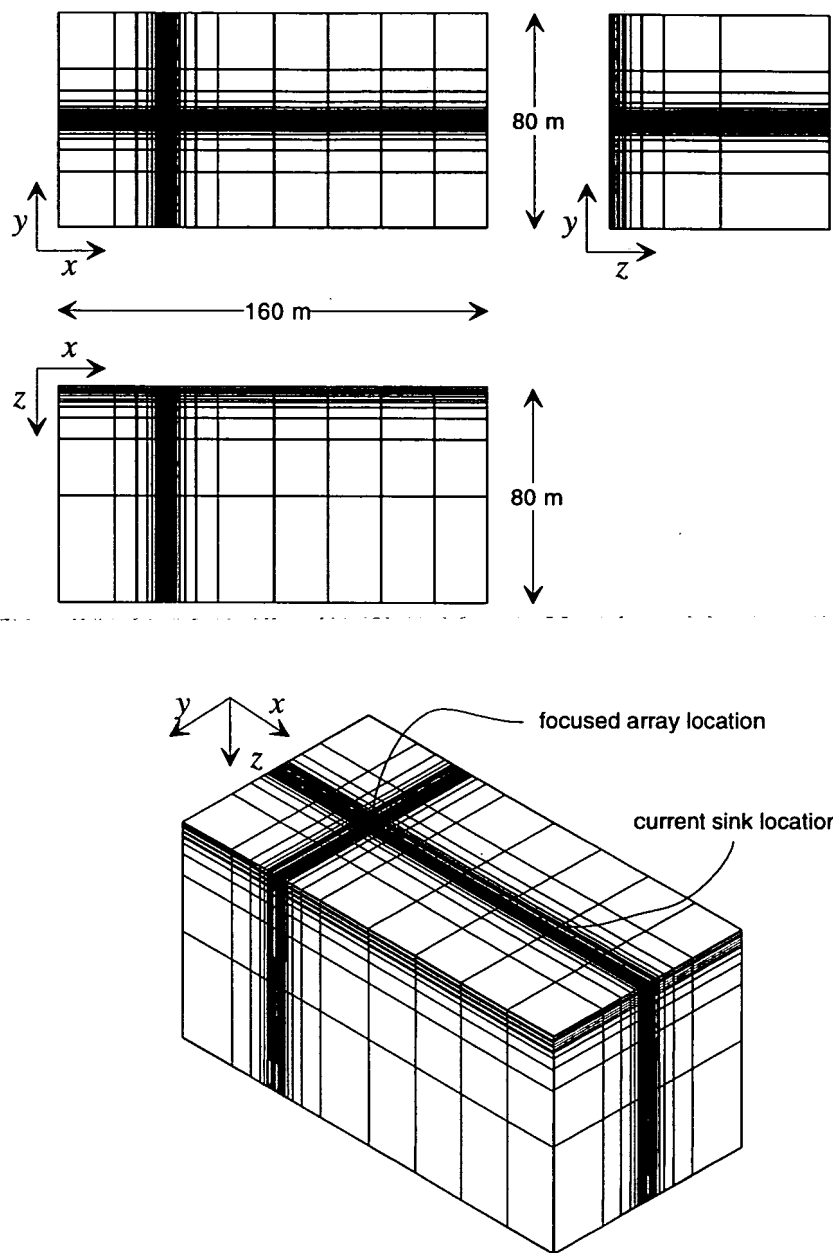


Figure 19 *rsc*. Model grid used in simulations of the focussed array.